PB85-212165

National Air Quality and
Emissions Trends Report, 1983

(U.S.) Environmental Protection Agency
Research Triangle Park, NC

Apr 85

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1. REPORT NO. EPA 450/4-84-029	2.	3. RECIPIENT'S ACCESSION NO. PB85 212165/AS
4. TITLE AND SUBTITLE National Air Quality and Emissions Trends Report, 1983		5. REPORT DATE April 1985
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) W. F. Hunt, Jr., (Editor), T. C. Curran, R. B. Faoro, N. H. Frank, C. Mann, R. E. Neligan, S. Sleva, N. Berg, D. Lutz, G. Manire, and D. Shipman		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Environmental Protection Agency Office of Air and Radiation Office of Air Quality Planning and Standards Research Triangle Park, North Carolina 27711		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES The confidence intervals and computer graphics were prepared by Alison Pollack of Systems Applications, Inc., under EPA Contract No. 68-02-3570.

16. ABSTRACT

This report presents national and regional trends in air quality from 1975 through 1983 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and lead. Both national and regional trends in each of the major pollutants are examined, as well as complimentary air quality trends in selected urban areas for the period 1980 through 1983. National air quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories.

In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements.

This report also includes a section, Air Quality Levels in Standard Metropolitan Statistical Areas (SMSA's). Its purpose is to provide interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all SMSA's with populations exceeding 500,000 for the years 1981, 1982 and 1983.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Trends Emission Trends Carbon Monoxide Nitrogen Dioxide Ozone Sulfur Dioxide Total Suspended Particulates Lead Air Pollution Standard Metropolitan Statistical Area (SMSA) Air Quality Statistics National Air Monitoring Stations (NAMS)		

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 254
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE $22.00

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

PB85-212165

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/4-84-029
April 1985

Air

EPA

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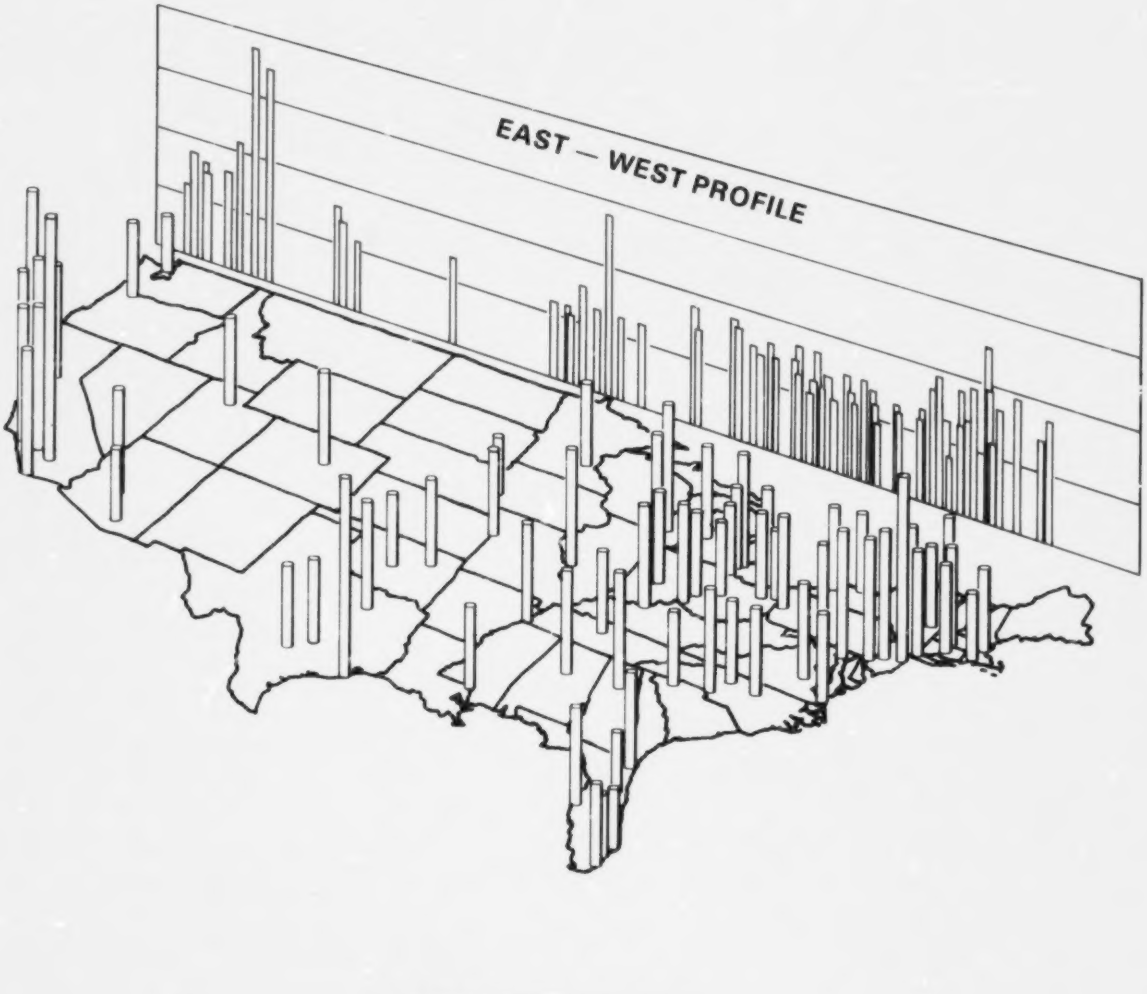

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EPA-450/4-84-029

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U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

April 1985

DISCLAIMER

This report has been reviewed by the Office of Air Quality Planning and Standards, Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

PREFACE

This is the eleventh annual report of air pollution trends issued by the Monitoring and Data Analysis Division of the U. S. Environmental Protection Agency. The report is directed toward both the technical air pollution audience and the interested general public. The Division solicits comments on this report and welcomes suggestions on our trend techniques, interpretations, conclusions, and methods of presentation. Please forward any response to William F. Hunt, Jr., (MD-14) U. S. Environmental Protection Agency, Monitoring and Data Analysis Division, Research Triangle Park, N. C. 27711.

The Monitoring and Data Analysis Division would like to acknowledge William F. Hunt, Jr., for the overall management, coordination, and direction given in assembling this report. Special mention should also be given to Helen Hinton for typing the report and Alison Pollack, Systems Applications, Incorporated for the calculation of confidence intervals and the preparation of graphics.

The following people are recognized for their contributions to each of the sections of the report as principal authors:

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Section 2 - William F. Hunt, Jr.
Section 3 - Thomas C. Curran, Robert B. Faoro, Neil H. Frank, and Warren Freas
Section 4 - William F. Hunt, Jr. and Robert B. Faoro
Section 5 - Stan Sleva, Neil Berg, David Lutz, George Manire, and Dennis Shipman

Also deserving special thanks are Warren Freas for assembling the air quality data base, Chuck Mann and Jake Summers for the emission trend analyses, and David Henderson and Coe Owen of EPA Region IX for providing us with their computer software to generate the air quality maps of the United States used in this report.

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NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1983

EXECUTIVE SUMMARY

NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1983

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

National long-term (1975 through 1983) improvements can be seen for sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb). Similar improvements have been documented in earlier air quality trends reports[1-10] issued by the U. S. Environmental Protection Agency (EPA). Improvements can also be seen for nitrogen dioxide (NO_2) in the period 1979 through 1983 and for total suspended particulate (TSP) between 1978 and 1983. In contrast to the other pollutants, ozone has increased slightly between 1979 and 1983 and has sharply increased between 1982 and 1983 through a combination of an increase in volatile organic chemical (VOC) emissions and meteorology which was generally more conducive to ozone formation in 1983 than in 1981 and 1982.

The trend in O_3 is complicated by a major drop in measured concentration levels which occurred between 1978 and 1979, largely due to a change in the O_3 measurement calibration procedure.[11] Therefore, special attention is given to the 1979 through 1982 period, because the change in the calibration procedure is not an influence during this period.

The trend in TSP is complicated by the fact that the glass fiber filters used to collect TSP data were changed in 1978, 1979, and again in 1982. Although the filters used in 1978, 1982 and 1983 were comparable, the filters used during 1979, 1980 and 1981 were different.[12,13] Therefore, special attention is given to the trend from 1978 to 1983, with less credence given to the intervening years.

In the ambient air quality trend analyses which follow, the National Air Monitoring Stations (NAMS) are compared with all the air monitoring sites meeting trends criteria. The NAMS provide accurate and timely data to EPA from a stream-lined, high quality, more cost-effective, national air monitoring network. They are generally located in areas with high pollutant concentrations and high population exposure. Because the NAMS are located in the more heavily polluted areas, the pollutant-specific trend lines for the NAMS are higher than the trend lines for all the trend sites taken together. In general, the rates of improvement observed at the NAMS are very similar to the rates of improvement observed at all the trend sites.

All of the ambient air quality trend analyses, which follow, are based on monitoring sites which recorded at least 7 of the 9 years of data in the period 1975 to 1983. Each year had to satisfy an annual data completeness criteria, which is discussed in Section 2.1, Data Base.

1.2 MAJOR FINDINGS

Total Suspended Particulate (TSP) - Annual average TSP levels measured at 1510 sites decreased 20 percent between 1975 and 1983 (Figure 1-1). This corresponds to a 33 percent decrease in estimated TSP emissions for the same period (Figure 1-2). TSP air quality levels generally do not improve in direct proportion to estimated emissions reductions, because air quality levels are influenced by factors such as natural dust, reintrained street dust, construction activity, etc., which are not included in the emissions estimates. Since 1977, the glass filters used throughout the nation at TSP monitoring sites have been centrally procured by EPA for the State and local agencies in order to obtain uniformity in TSP collection nationwide at reduced cost. The filters used in 1979, 1980 and 1981 were found to record higher values than the filters used in 1978 and 1982, because of higher filter alkalinity, which is related to artifact error.[12,13] The filters used in 1978, 1982 and 1983 were supplied by the same manufacturer and found to be comparable based on similar alkalinity levels. Therefore, although the air quality values for 1979, 1980 and 1981 are probably biased high, the trend between 1978 and 1983 is valid. The air quality improvement between 1978 and 1983 is due not only to reductions in TSP emissions, but also to more favorable meteorology in 1983. An analysis of meteorological conditions for 1983 indicated a potential for lower TSP concentrations due to abnormally high precipitation.

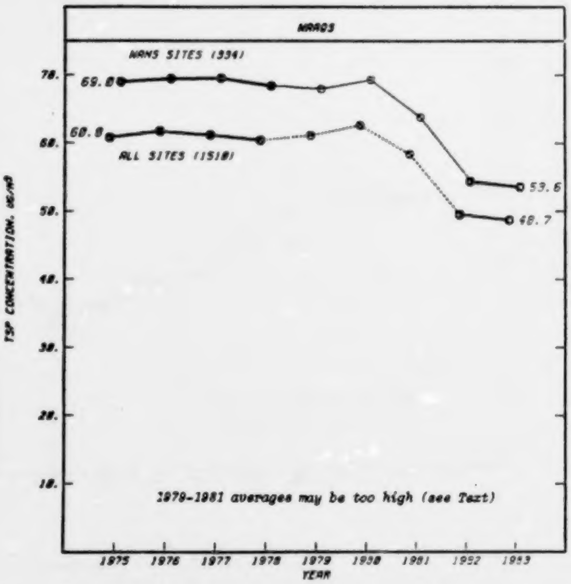

FIGURE 1-1. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE GEOMETRIC MEAN TOTAL SUSPENDED PARTICULATE AT BOTH NAMS AND ALL SITES, 1975 - 1983.

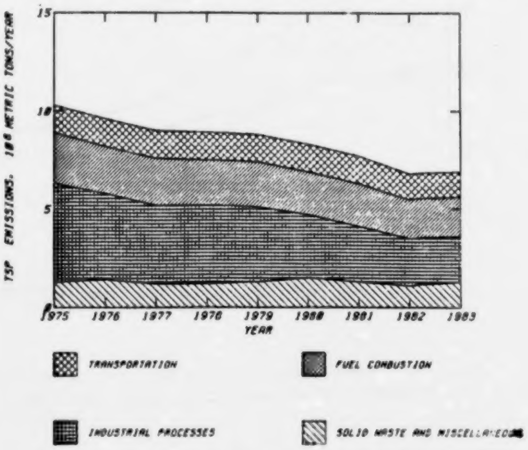

FIGURE 1-2. NATIONAL TREND IN PARTICULATE EMISSIONS, 1975-1983

Sulfur Dioxide (SO_2) - Annual average SO_2 levels measured at 286 sites with continuous SO_2 monitors decreased 36 percent from 1975 to 1983 (Figure 1-3). A comparable decrease of 43 percent was observed in the trend in the composite average of the second maximum 24-hour averages (Figure 1-4). An even greater improvement was observed in the estimated number of exceedances of the 24-hour standard, which decreased 92 percent (Figure 1-5). Correspondingly, there was a 19 percent drop in sulfur oxide emissions (Figure 1-6). The difference between emissions and air quality trends arises because the use of high sulfur fuels was shifted from power plants in urban areas, where most of the monitors are, to power plants in rural areas which have fewer monitors. Further, the residential and commercial areas, where the monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvements. These decreases in sulfur oxide emissions are due to a combination of energy conservation measures and the use of cleaner fuels in the residential and commercial areas.

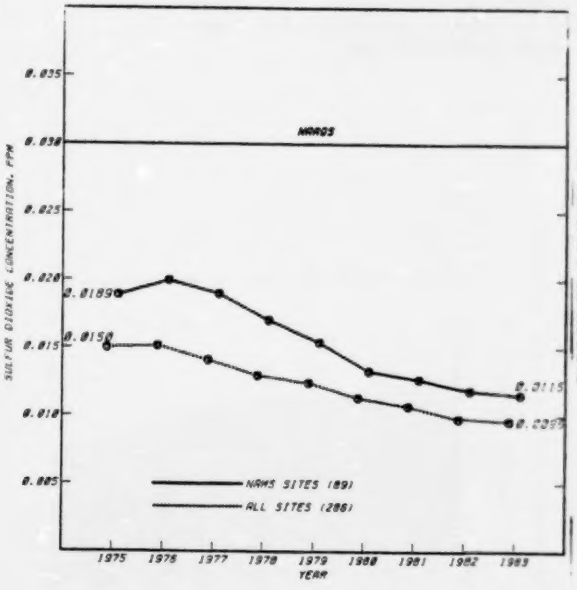

FIGURE 1-3. NATIONAL TREND IN THE ANNUAL AVERAGE SULFUR DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES, 1975 - 1983.

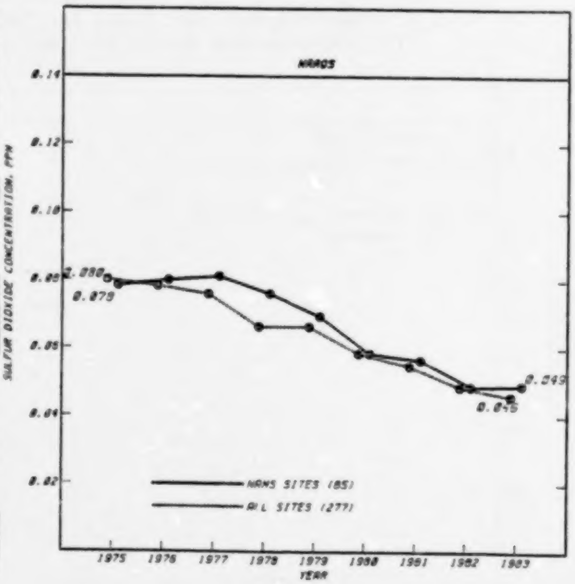

FIGURE 1-4. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND-HIGHEST 24-HOUR SULFUR DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES, 1975 - 1983.

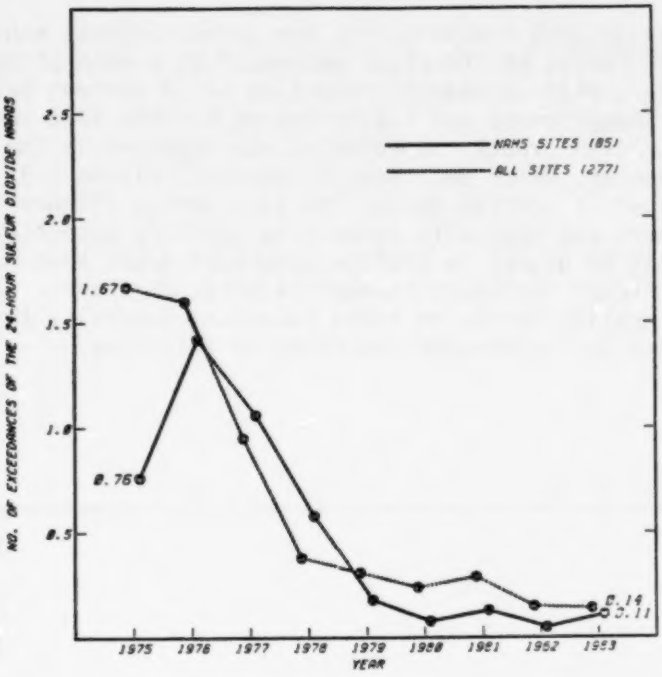

FIGURE 1-5. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE ESTIMATED NUMBER OF EXCEEDANCES OF THE 24-HOUR SULFUR DIOXIDE NAAQS AT BOTH NAMS AND ALL SITES. 1975 - 1983.

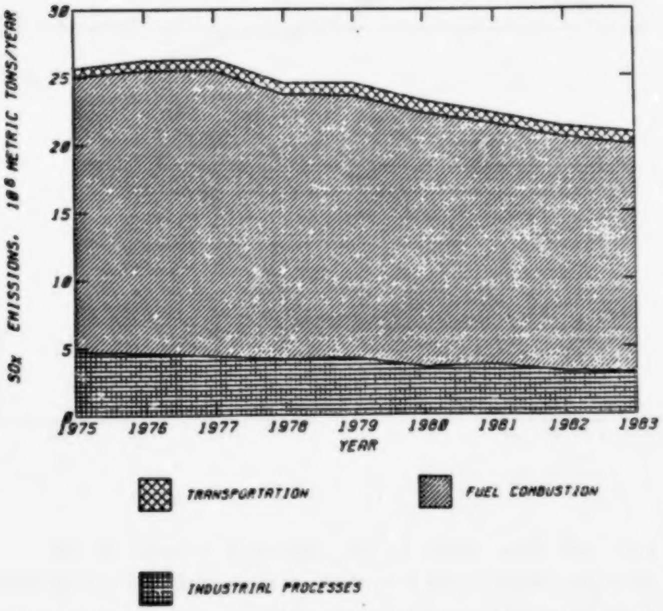

FIGURE 1-6. NATIONAL TREND IN SULFUR OXIDE EMISSIONS. 1975-1983.

Carbon Monoxide (CO) - Nationally, the second highest non-overlapping 8-hour average CO levels at 174 sites decreased at a rate of approximately 5 percent per year, with an overall reduction of 33 percent between 1975 and 1983 although there was little change between 1982 and 1983 (Figure 1-7). An even greater improvement was observed in the estimated number of exceedances, which decreased 87 percent (Figure 1-8). CO emissions decreased 16 percent during the same period (Figure 1-9). Because CO monitors are typically located to identify potential problems, they are likely to be placed in traffic saturated areas that may not experience significant increases in vehicle miles of travel. As a result, the air quality levels at these locations generally improve at a rate faster than the nationwide reduction in emissions.

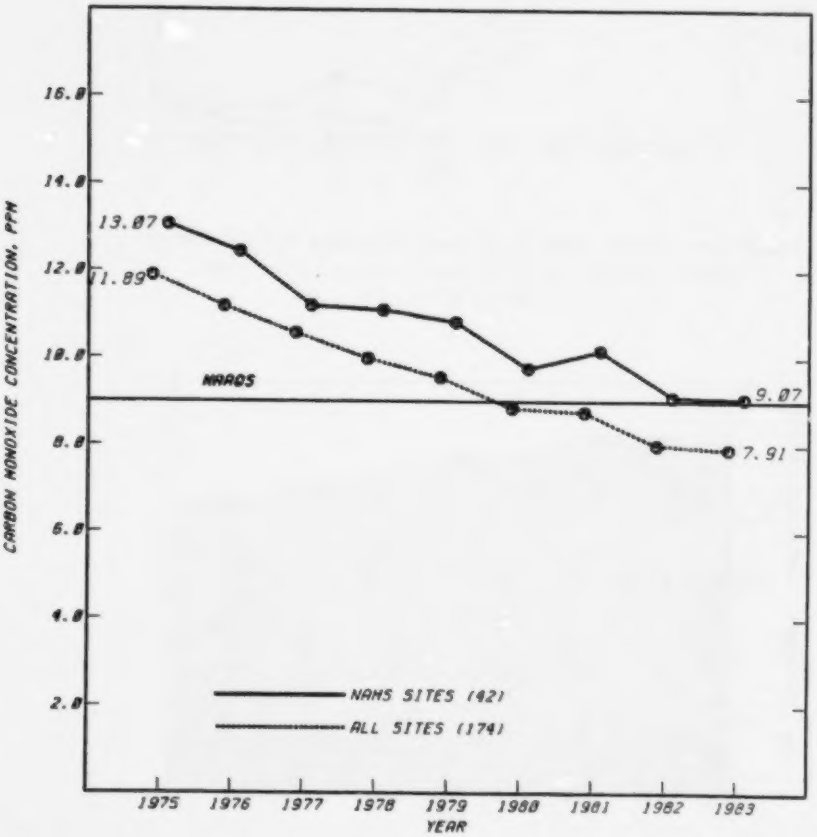

FIGURE 1-7. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND HIGHEST NONOVERLAPPING 8-HOUR AVERAGE CARBON MONOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES, 1975 - 1983.

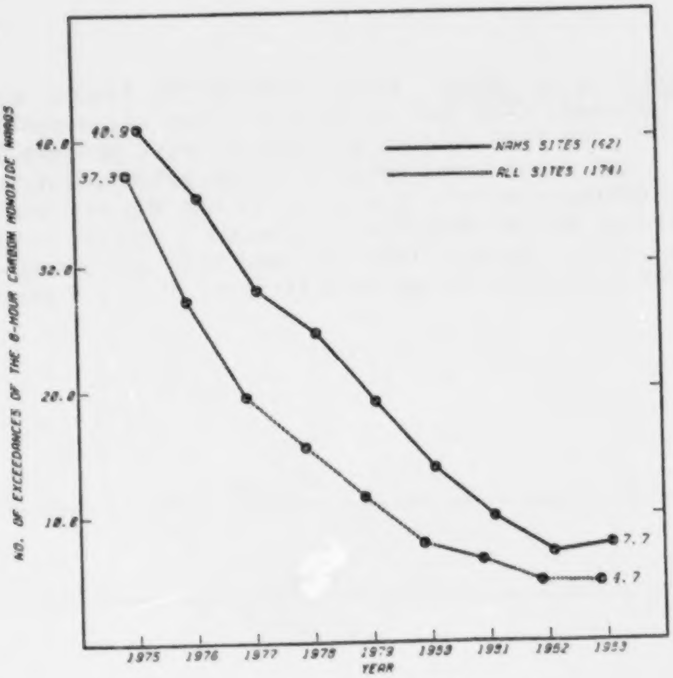

FIGURE 1-8. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE ESTIMATED NUMBER OF EXCEEDANCES OF THE 8-HOUR CARBON MONOXIDE NAAQS AT BOTH NAMS AND ALL SITES, 1975 - 1983.

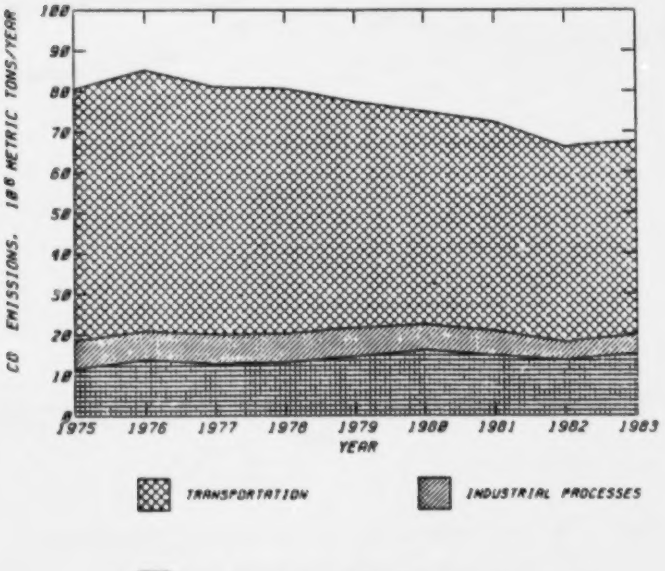

FIGURE 1-9. NATIONAL TREND IN EMISSIONS OF CARBON MONOXIDE, 1975-1983.

Nitrogen Dioxide (NO_2) - Annual average NO_2 levels, measured at 177 sites, increased from 1975 to 1979 and then began declining (Figure 1-10). The 1983 ambient NO_2 levels are 4 percent less than the 1975 levels. While the trend pattern in the estimated nationwide emissions of nitrogen oxides is similar to the NO_2 air quality trend pattern, nitrogen oxides emissions increased 2 percent between 1975 and 1983 (Figure 1-11). Between 1979 and 1983 both ambient NO_2 levels and nitrogen oxide emissions showed reductions of 15 and 8 percent, respectively.

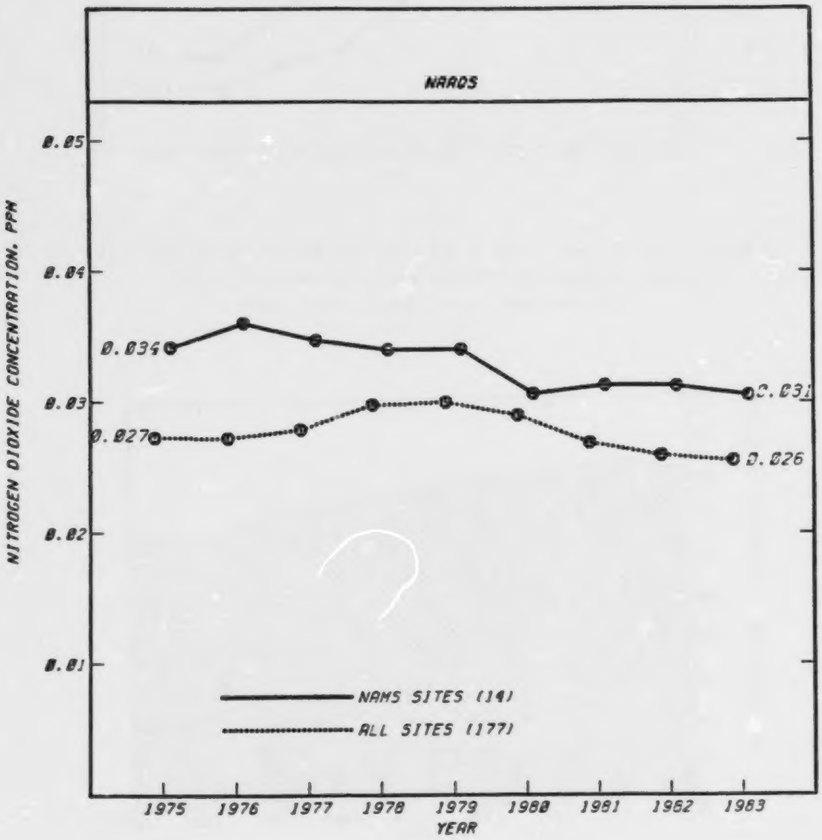

FIGURE 1-10. NATIONAL TREND IN THE COMPOSITE AVERAGE OF NITROGEN DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES, 1975 - 1983.

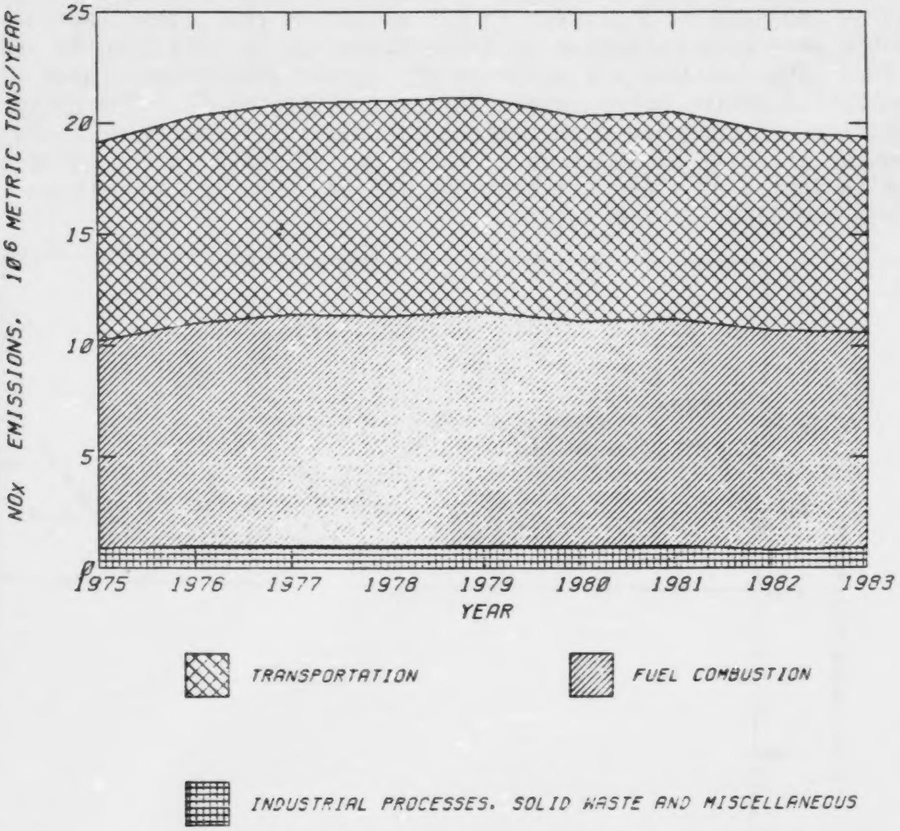

FIGURE 1-11. NATIONAL TREND IN EMISSIONS OF NITROGEN OXIDES. 1975-1983.

Ozone (O_3) - Nationally, the composite average of the second-highest daily maximum 1-hour O_3 values, recorded at 176 sites, decreased 8 percent between 1975 and 1983 (Figure 1-12). Volatile organic compound (VOC) emissions decreased 12 percent during the same period (Figure 1-13). The improvement in ozone levels, however, between 1975 and 1983 is largely due to the change in the calibration procedure, which took place between 1978 and 1979. In the period following the calibration change (1979 to 1983), ozone levels increased slightly, 1 percent, between 1979 and 1983, and sharply, 12 percent, between 1982 and 1983. The increase between 1982 and 1983 appears to be due to a combination of an increase of 3 percent in VOC emissions and meteorological conditions which were more conducive to ozone formation in 1983 than in 1981 and 1982. The increase was observed all across the United States with the exception of the Northwestern States (EPA Region X). The patterns observed in changing ozone levels are similarly observed in the estimated number of daily exceedances of the ozone standard in the ozone season, which increased 6 percent between 1979 and 1983 and 46 percent between 1982 and 1983 (Figure 1-14).

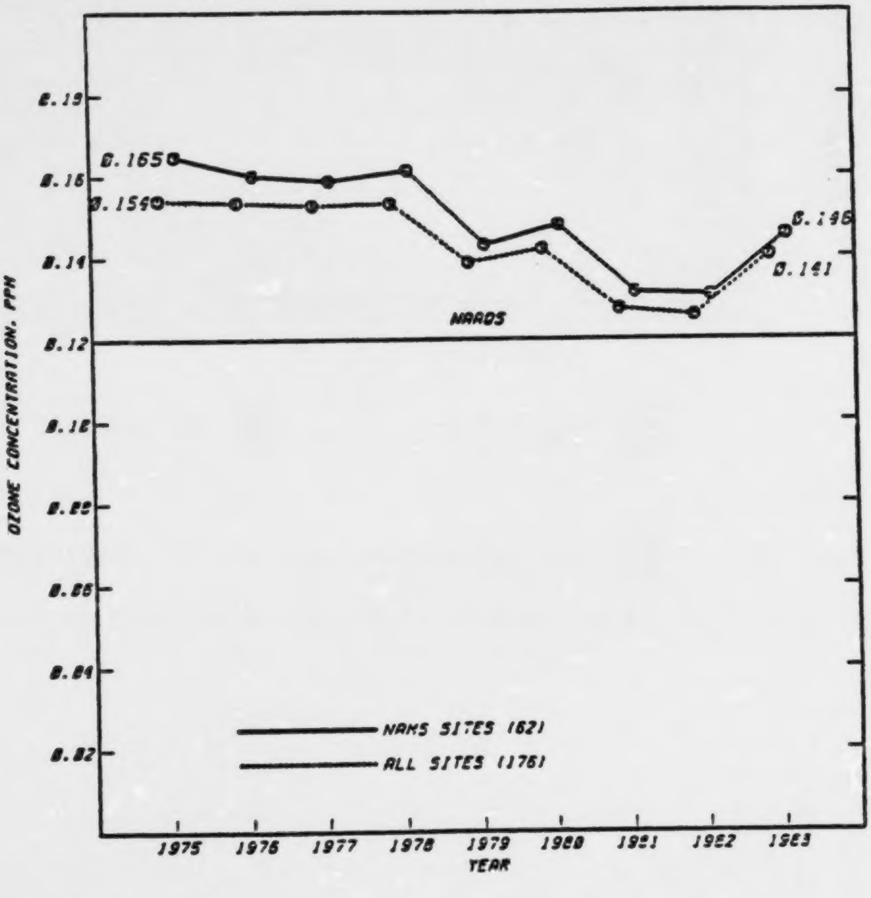

FIGURE 1-12. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND HIGHEST DAILY MAXIMUM 1-HOUR OZONE CONCENTRATION AT BOTH NAMS AND ALL SITES, 1975 - 1983.

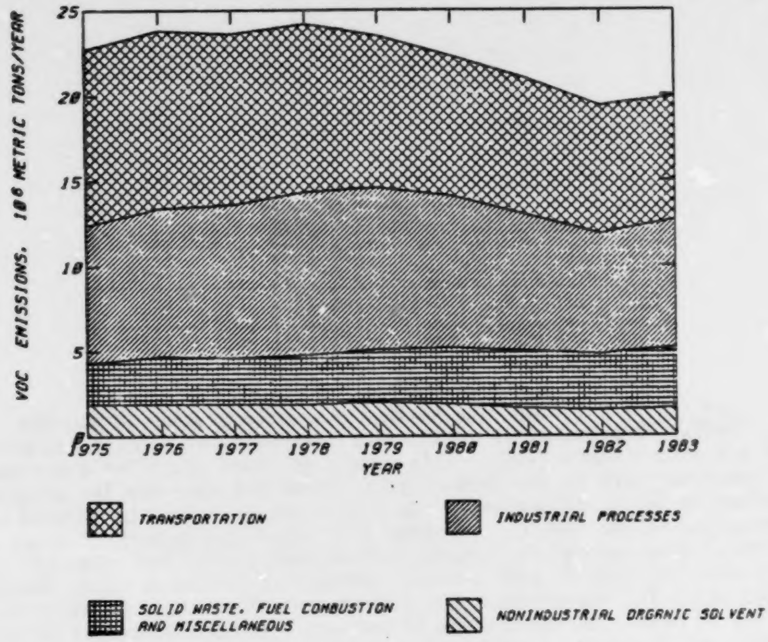

Figure 1-13. NATIONAL TREND IN EMISSIONS OF VOLATILE ORGANIC COMPOUNDS, 1975-1983.

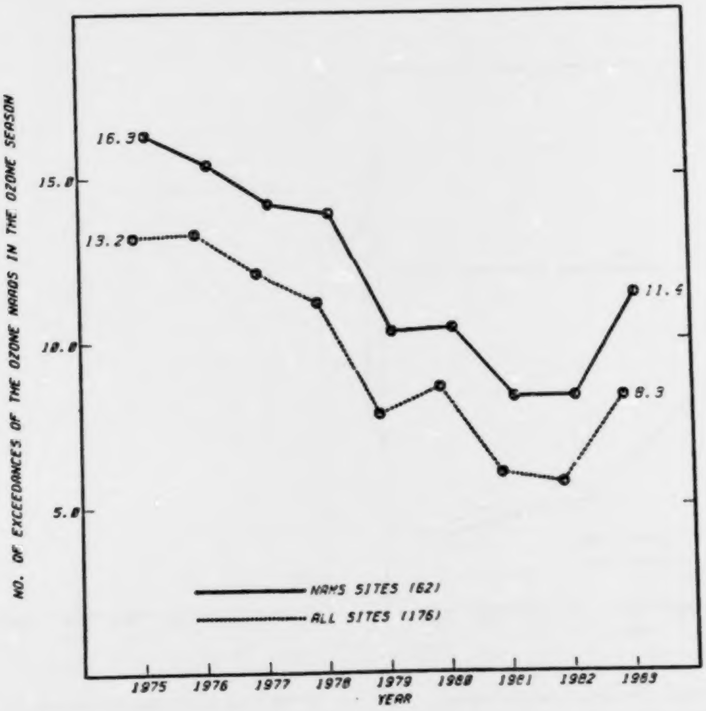

Figure 1-14. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE NUMBER OF DAILY EXCEEDANCES OF THE OZONE NAAQS IN THE OZONE SEASON AT BOTH NAMS AND ALL SITES, 1975 - 1983.

Lead (PB) - The composite maximum quarterly average of ambient lead levels, recorded at 61 urban sites, decreased 67 percent between 1975 and 1983 (Figure 1-15). This sample of sites satisfied a minimum of 7 years of data in the 1975-83 time period and were heavily weighted by sites in Texas (39 percent). In all, a total of only ten states were represented in the sample. In order to increase the number of sites and their geographical representativeness lead trends were studied again over the 1980-83 time period. A total of 138 urban sites from 28 states satisfied the minimum data requirement of at least 3 out of the 4 years of data. An improvement in ambient lead concentrations of 34 percent was observed at these sites and for the 61 sites mentioned above over this same 1980-83 period. Even this larger group of sites was disproportionately weighted by sites in Arizona, California, Minnesota, Pennsylvania, and Texas. These five states accounted for 52 percent of the 138 sites represented. The lead consumed in gasoline dropped 75 percent from 1975-83, primarily due to the use of unleaded gasoline in catalyst equipped cars and the reduced lead content in leaded gasoline (Figure 1-16). Likewise, trends in national lead emissions showed a drop of 68 percent (Figure 1-17).

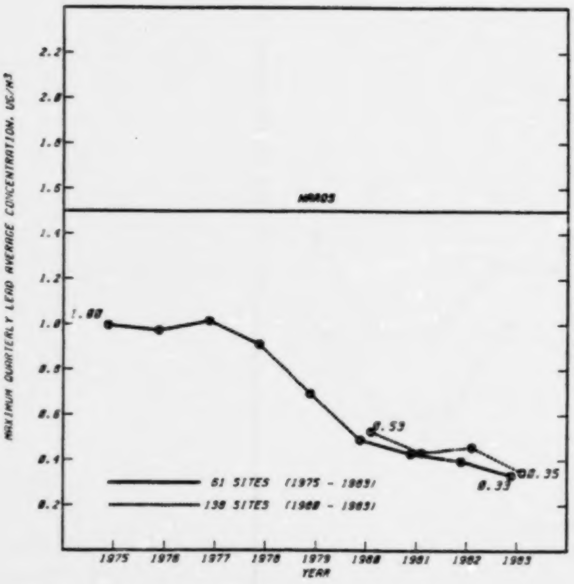

FIGURE 1-15. NATIONAL TREND IN MAXIMUM QUARTERLY AVERAGE LEAD LEVELS AT 61 SITES (1975 - 1983) AND 138 SITES (1980 - 1983).

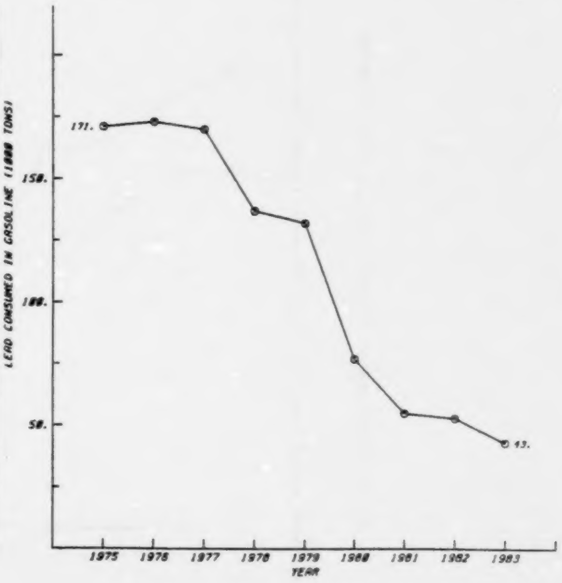

FIGURE 1-16. LEAD CONSUMED IN GASOLINE, 1975 - 1983.

(SALES TO THE MILITARY EXCLUDED)

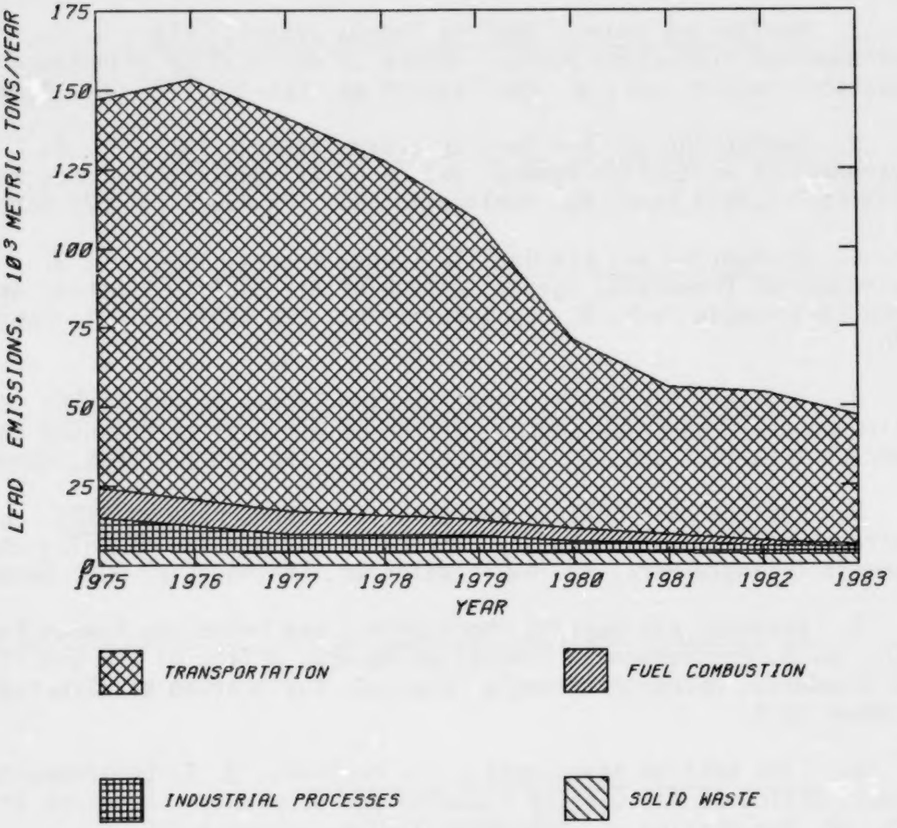

FIGURE 1-17. NATIONAL TREND IN LEAD EMISSIONS, 1975-1983.

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2. INTRODUCTION

This report focuses on long-term (1975-1983) national air quality trends in each of the major pollutants as well as Regional and, where appropriate, short-term air quality trends. The national analyses are complimented with a new section (Section 5) on air quality trends in selected urbanized areas for the period 1980 through 1983. The shorter time period was used in the selected urbanized area analyses to expand the number of sites available for trend analysis. The areas that were examined are: Atlanta, GA; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Houston, TX; Los Angeles-Long Beach, CA; New York, NY-Northeastern NJ; Philadelphia, PA-NJ; Portland, OR-WA; and St. Louis, MO-IL.

The national air quality trends are presented for all sites and the National Air Monitoring Station (NAMS) sites. The NAMS were established through monitoring regulations promulgated in May 1979[1] to provide accurate and timely data to the U. S. Environmental Protection Agency (EPA) from a national air monitoring network. The NAMS are located in areas with high pollutant concentrations and high population exposure. These stations meet uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States. Other sites operated by the State and local air pollution control agencies, such as the State and Local Air Monitoring Stations (SLAMS) and Special Purpose Monitors (SPM), in general, also meet the same rigid criteria, except that in addition to being located in the area of highest concentration and high population exposure, they are located in other areas as well.

In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements. The emission trends are taken from the EPA publication, National Air Pollutant Emission Estimates, 1940-1983[2] and the reader is referred to this publication for more detailed information.

Air quality progress is measured by comparing the ambient air pollution levels with the appropriate primary and secondary National Ambient Air Quality Standards (NAAQS) for each of the pollutants (Table 2-1). Primary standards protect the public health; secondary standards protect the public welfare as measured by effects of pollution on vegetation, materials, and visibility. The standards are further categorized for long or short term exposure. Long-term standards specify an annual or quarterly mean that may not be exceeded; short-term standards specify upper limit values for 1-, 3-, 8-, or 24-hour averages. With the exception of the pollutant ozone, the short-term standards are not to be exceeded more than once per year. The ozone standard requires that the expected number of days per calendar year with daily maximum hourly concentrations exceeding 0.12 parts per million (ppm) be less than or equal to one.

TABLE 2-1. National Ambient Air Quality Standards (NAAQS)

POLLUTANT	PRIMARY (HEALTH RELATED)		SECONDARY (WELFARE RELATED)	
	AVERAGING TIME	CONCENTRATION	AVERAGING TIME	CONCENTRATION
TSP	Annual Geometric Mean	75 ug/m^3	Annual Geometric Mean	60 ug/m^3*
	24-hour	260 ug/m^3	24-hour	150 ug/m^3
SO_2	Annual Arithmetic Mean	(0.03 ppm) 80 ug/m^3	3-hour	1300 ug/m^3 (0.50 ppm)
	24-hour	(0.14 ppm) 365 ug/m^3		
CO	8-hour	(9 ppm) 10 mg/m^3	Same as Primary	
	1-hour	(35 ppm) 40 mg/m^3	Same as Primary	
NO_2	Annual Arithmetic Mean	(0.053 ppm) 100 ug/m^3	Same as Primary	
O_3	Maximum Daily 1-hour Average	0.12 ppm (235 ug/m^3)	Same as Primary	
Pb	Maximum Quarterly Average	1.5 ug/m^3	Same as Primary	

*This annual geometric mean is a guide to be used in assessing implementation plans to achieve the 24-hour standard of 150 ug/m^3.

Section 4 of this report, "Air Quality Levels in Standard Metropolitan Statistical Areas (SMSA's);" provides interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all SMSA's with populations exceeding 500,000 for the years 1981, 1982 and 1983.

2.1 DATA BASE

The ambient air quality data used in this report were obtained from EPA's National Aerometric Data Bank (NADB). Air quality data are submitted to the NADB by both State and local governments, as well as federal agencies. At the present time, there are over 250 million air pollution measurements on the NADB, the vast majority of which represent the more heavily populated urban areas of the Nation.

As in last year's report[3], the size of the available air quality trends data base has been expanded by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or a change in the project code, such as a change from residential to commercial. A discussion of the impact of the merging of the air quality data is presented in each of the individual pollutant discussions.

In order for a monitoring site to have been included in the national trend analysis, the site had to contain at least 7 out of the 9 years of data in the period 1975 to 1983. For the urban area analyses, the site had to contain 3 out of 4 years of data to be included as a trend site. Each year with data had to satisfy an annual data completeness criterion. To begin with, the air quality data are divided into two major groupings -- 24-hour measurements and continuous 1-hour measurements. The 24-hour measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and are operated on a systematic sampling schedule of once every 6 days or 61 samples per year. Such instruments are used to measure TSP, SO_2, NO_2, and Pb. For these measurement methods, the NADB defines a valid quarter's record as one consisting of at least five sample measurements representively distributed among the months of that quarter. Distributions of measurements that show no samples in 2 months of a quarter or that show no samples in 1 month and only one sample in another month are judged unacceptable for calculating a representative estimate of the mean. A valid annual mean for TSP, SO_2 and NO_2, measured with this type of sampler, requires four valid quarters to satisfy the NADB criteria. For the pollutant lead, the data used has to satisfy the criteria for a valid quarter in at least 3 of the 4 possible quarters in a year for the national trend. In the case of the urban areas, only 1 valid quarter was required in order to maximize the number of lead sites available for trends.

The 1-hour data are obtained from monitoring instruments that operate continuously, producing a measurement every hour for a possible total of 8760 hourly measurements in a year. For continuous hourly data, a valid annual mean for SO_2 and NO_2 requires at least 4380 hourly observations. This same annual data completeness criteria of at least 4380 hourly values was required for the CO standard related statistics - the second maximum nonoverlapping 8-hour average and the estimated number of exceedances of the 8-hour average CO standard.

A slightly different criteria was used for the SO_2 standard related daily statistics - the second daily maximum 24-hour average and the estimated number of daily exceedances of the SO_2 standard. Instead of requiring 4380 or more hourly values, 182 or more daily values were required. A valid day is defined as one consisting of at least 18 hourly observations. This minor modification in the criteria resulted in a 3 percent difference in the total number of SO_2 trend sites for

Finally, because of the seasonal nature of ozone, both the second daily maximum 1-hour value and the estimated number of exceedances of the O_3 NAAQS were calculated for the ozone season, which varies by state.[4] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October. In order for a site to be included it had to have at least 50 percent of the hourly data in the ozone season.

For all the pollutants, the site must satisfy the annual completeness criterion, specified above, in at least 7 out of 9 years to be included in the air quality trends data base and 3 out of 4 years in the urbanized area trend data bases. The shorter time period was used in the urbanized area analyses to expand the number of sites available for trend analyses.

In performing the national trend analyses, each site was weighted equally. The trend sites can be found in all 10 EPA Regions (Figure 2-1) for TSP, SO_2, CO and O_3. The trend sites can be found in 8 of the 10 Regions for NO_2 and 5 Regions for lead. A comparison was made between EPA Regional population and the distribution of trend sites by pollutant (Table 2-2). Spearman rank correlation coefficients were computed[5], relating the 1980 Regional population with the number of trend sites. With the exception of the lead sites, statistically significant relationships were found between the distribution of trend sites and Regional population. This suggests that there is a relationship between population and the distribution of monitoring sites, as would be expected. In general, the trend sites are located in populated areas which have experienced air pollution problems. The data base for the lead trend sites is heavily weighted by concentrations of monitors in a relatively small number of States. This is addressed in the lead trends section of the report (Section 3.6).

2.2 TREND STATISTICS

The air quality analyses presented in this report comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators.[6] This task force was established in January 1980 to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends. The Task Force report was published in February 1981. The air quality statistics used in these pollutant-specific trend analyses relate directly to the appropriate NAAQS's. Two types of standard-related statistics are used - peak statistics (the second maximum 24-hour SO_2 average, the second maximum nonoverlapping 8-hour CO average, and the second daily maximum 1-hour O_3 average) and long-term averages (the annual geometric mean for TSP, the annual arithmetic means for SO_2 and NO_2, and the quarterly arithmetic mean for lead). In the case of the peak statistics, the second maximum value is used,

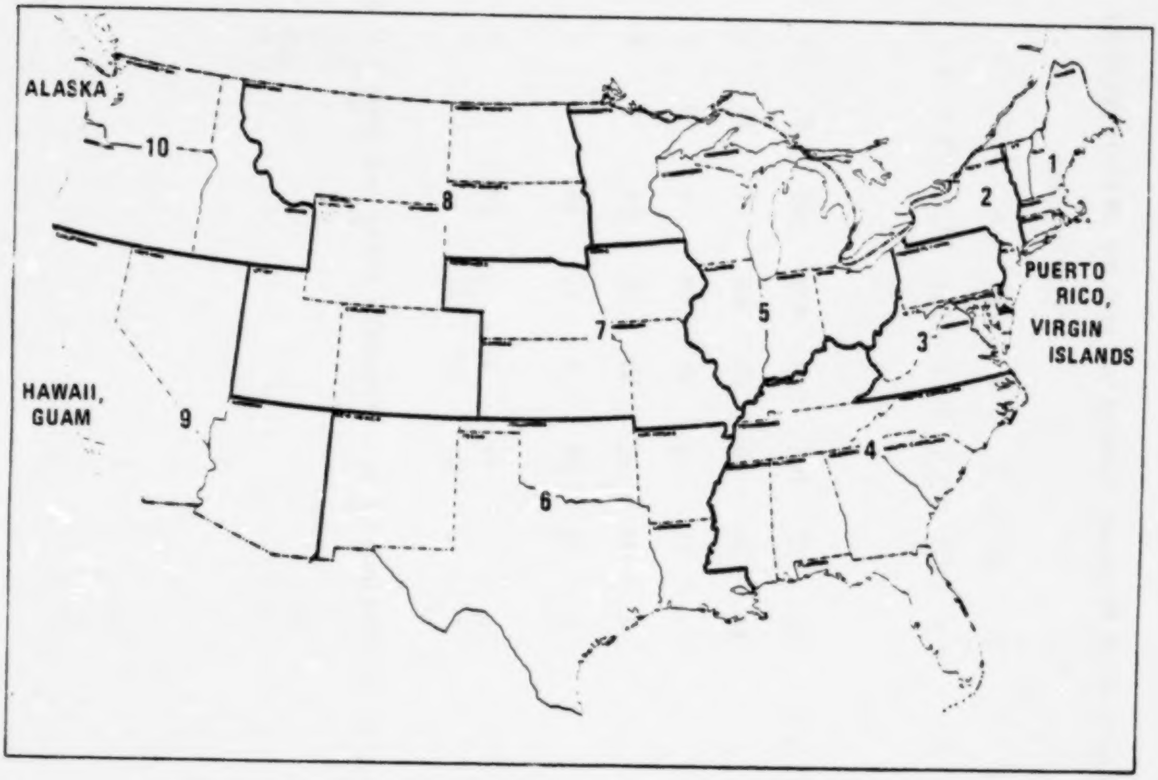
ALASKA
10
8
7
5
1
2
3
4
6
9
PUERTO RICO, VIRGIN ISLANDS
HAWAII, GUAM

Figure 2-1. Ten regions of the U. S. Environmental Protection Agency.

TABLE 2-2. Comparison of Regional Population and the Distribution of Trend Sites by Pollutant

	EPA REGIONS										SPEARMAN RANK CORRELATION (Population vs. Pollutant Specific Sites)
	1	2	3	4	5	6	7	8	9	10	
REGIONAL POPULATION (millions)	12.3	28.7	23.5	35.7	45.1	11.6	22.9	6.4	25.7	7.3	
DISTRIBUTION OF SITES											
Total Suspended Particulate (TSP)	48	172	141	249	438	158	95	76	70	63	0.70 ***
Sulfur Dioxide (SO_2)	17	39	24	71	66	14	10	5	32	8	0.95 ****
Carbon Monoxide (CO)	7	31	10	10	28	9	9	9	47	14	0.58 *
Nitrogen Dioxide (NO_2)	0	6	15	40	38	23	6	8	41	0	0.55 *
Ozone (O_3)	6	19	26	14	40	15	8	7	36	5	0.73 ***
Lead (Pb)											
61 Sites (1975-1983)	0	0	12	4	8	24	0	0	13	0	0.29
138 Sites (1980-1983)	4	3	31	16	35	13	3	1	30	2	0.37

*****The Spearman Rank Correlation Coefficient is significantly different from 0.0 at x = 0.0005
**** " " " " " " " " " 0.0 " x = 0.005
*** " " " " " " " " " 0.0 " x = 0.01
** " " " " " " " " " 0.0 " x = 0.025
* " " " " " " " " " 0.0 " x = 0.05

because this is the value which traditionally has been used to determine whether or not a site has or has not violated an air quality standard in a particular year, and, therefore, the second maximum value is of significant importance. A composite average of each of these statistics is used, by averaging each statistic over all available trend sites, in the graphical presentations which follow.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

The emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year.[2] These are estimates of the amount and kinds of pollution being generated by automobiles, factories, and other sources, based upon the best available engineering calculations for a given time period.

2.3 REFERENCES

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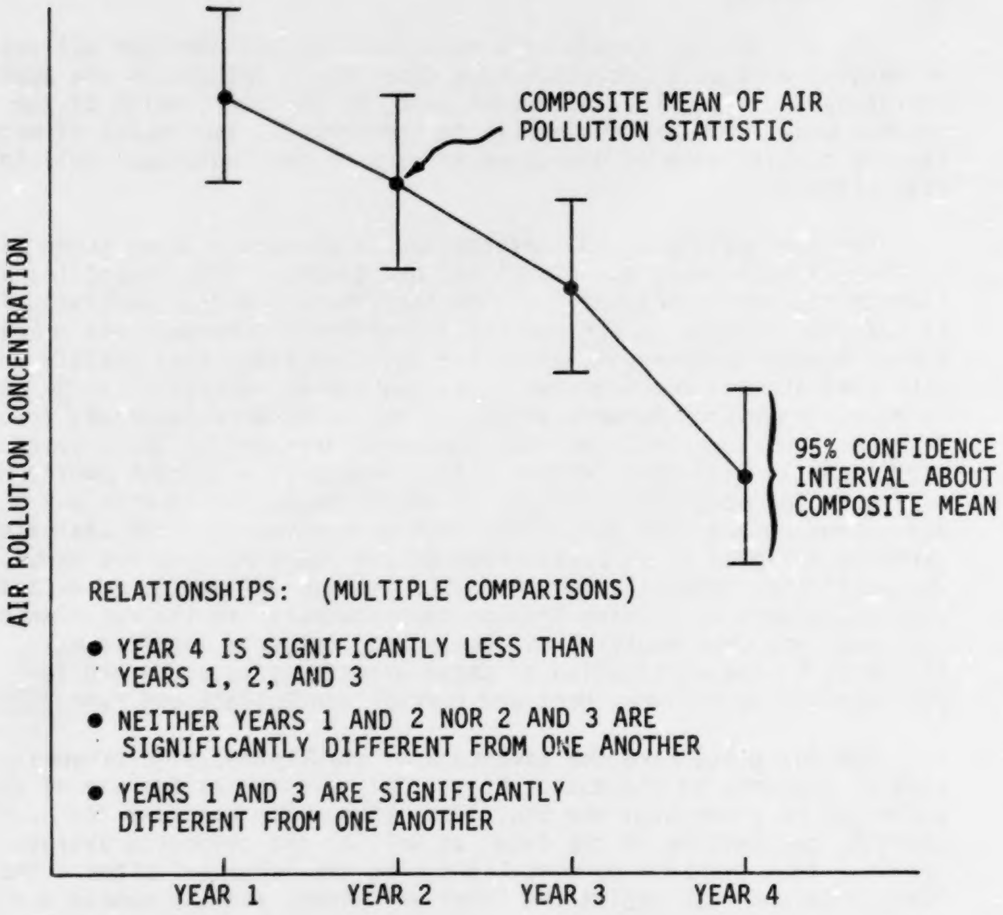
3. NATIONAL AND REGIONAL TRENDS IN CRITERIA POLLUTANTS

This chapter focuses on long-term trends in each of the six major pollutants. Comparisons are made between all the trend sites and the subset of NAMS. Trends are examined for both the Nation and the ten EPA Regions. Where appropriate, trend analyses are also presented for selected States.

The air quality trends data base has been expanded for all pollutants by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as residential to commercial. The impact of merging the air quality data is discussed in each of the individual pollutant discussions.

The air quality trends information is presented using trend lines, confidence intervals, Box plots[1] and bar graphs. This report introduces statistical confidence intervals to facilitate a better understanding of measured changes in air quality. Confidence intervals are placed around composite averages, which are based on sites that satisfy annual data completeness requirements. The confidence intervals can be used to make comparisons between years; if the confidence intervals for any 2 years do not overlap, then the composite averages of the 2 years are significantly different (Figure 3-1). Ninety-five percent confidence intervals for composite averages of annual means (arithmetic and geometric) and second maxima were calculated with a repeated measures analysis of variance followed by an application of the Tukey Studentized Range.[2] The confidence intervals for composite averages of estimated exceedances were calculated by fitting Poisson distributions[3] to the exceedances each year and then applying the Bonferroni multiple comparisons procedure.[4] The utilization of these procedures is explained in publications by Pollack, Hunt and Curran[5] and Pollack and Hunt.[6]

The Box plots have the advantage of displaying, simultaneously, several features of the data. Figure 3-2 illustrates the use of this technique in presenting the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average. The 5th, 10th and 25th percentiles depict the "cleaner" sites. The 75th, 90th and 95th depict the "dirtier" sites, and the median and average describe the "typical" sites. For example, 90 percent of the sites would have concentrations lower than the 90th percentile. Although the average and median both characterize typical behavior, the median has the advantage of not being affected by a few extremely high observations. The use of the Box plots allow us to simultaneously compare trends in the "cleaner", "typical" and "dirtier" sites. Bar graphs are used for the Regional comparisons. The composite average of the appropriate air quality statistic of the earlier time period is compared with the



RELATIONSHIPS: (MULTIPLE COMPARISONS)

- YEAR 4 IS SIGNIFICANTLY LESS THAN YEARS 1, 2, AND 3
- NEITHER YEARS 1 AND 2 NOR 2 AND 3 ARE SIGNIFICANTLY DIFFERENT FROM ONE ANOTHER
- YEARS 1 AND 3 ARE SIGNIFICANTLY DIFFERENT FROM ONE ANOTHER

Figure 3-1 Sample illustration of use of confidence intervals to determine statistically significant change.

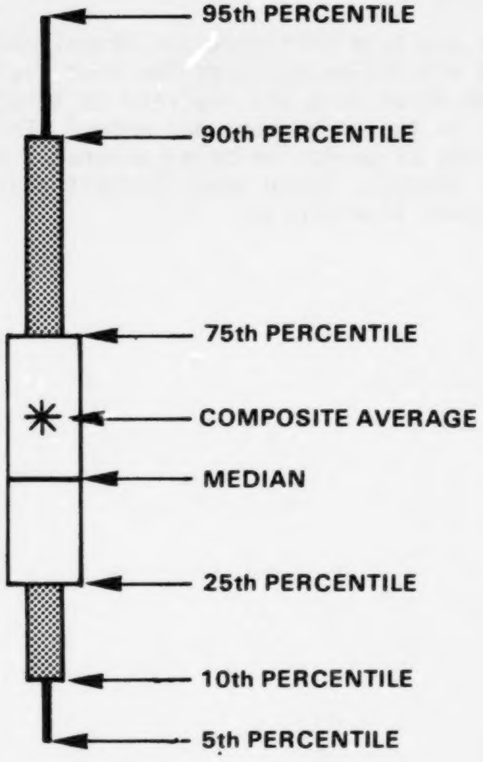

95th PERCENTILE
90th PERCENTILE
75th PERCENTILE
COMPOSITE AVERAGE
MEDIAN
25th PERCENTILE
10th PERCENTILE
5th PERCENTILE

Figure 3-2. Illustration of plotting conventions for box plots.

composite average of the later time period. The approach is simple and it allows the reader at a glance to compare the long term trend in all ten EPA Regions.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

Finally, trends are also presented for annual nationwide emissions. These emissions data are estimated using the best available engineering calculations. The emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year.[7] These are estimates of the amount and kinds of pollution being generated by automobiles, factories, and other sources, based upon the best available engineering calculations for a given time period.

3.1 TRENDS IN TOTAL SUSPENDED PARTICULATE

Total Suspended Particulate (TSP) is a measure of suspended particles in the ambient air ranging up to 25-45 micrometers in diameter. These particles originate from a variety of stationary and mobile sources. TSP is measured using a high volume sampler which simply measures the total ambient particle concentration. It does not provide information regarding particle size. There are both annual geometric mean and 24-hour National Ambient Air Quality Standards for TSP. The annual geometric mean standard is 75 micrograms per cubic meter (ug/m^3) not to be exceeded, while the 24-hour standard is 260 ug/m^3 not to be exceeded more than once per year. Because the annual mean is a more stable estimation of air quality, given the EPA recommended sampling frequency of once every 6 days, only the annual mean is used as a trend statistic.

3.1.1 Long-Term TSP Trends, 1975-83

The 9-year trend in average TSP levels, 1975-1983, is shown in Figure 3-3 for over 1500 sites geographically distributed throughout the Nation and for the subset of 334 National Air Monitoring Stations (NAMS) which are located in the large urban areas. The TSP levels are expressed in terms of the composite average annual geometric mean.

The curves shown in Figure 3-3 indicate a very slight decrease in composite levels from 1975-1981, followed by a sizeable decrease between 1981 and 1982 and a small decrease between 1982 and 1983. The NAMS sites show higher composite levels than the sites for the Nation in general, but appear to show a similar pattern. The composite average of TSP levels measured at 1510 sites, distributed throughout the Nation, decreased 20 percent during the 1975 to 1982 time period and the NAMS decreased 22 percent. From the curves in Figure 3-3, it appears that most of this decrease occurred between the measured levels of 1981 and 1982. EPA has found, however, that the TSP data collected during the years 1979-1981 may be biased high due to the glass fiber filter used during these years, and that most of the large apparent 2-year decrease in pollutant concentrations between 1981 and 1982 can be attributed to a change in these filters.[8,9] For this reason the trend line in Figure 3-3 is dotted between 1978 and 1982. Due to the change in TSP filters which will be discussed in the following paragraphs, the pattern of the yearly change in TSP between 1978 and 1982 is difficult to assess. On the basis of comparable filters used in 1978 and 1983, however, the long-term (5-year) improvement in TSP is estimated to be 20 percent.

Since 1977, the glass fiber filters have been centrally procured by EPA for the nation's monitoring sites for reasons of nationwide uniformity and costs. The competitive procurement process resulted in changes in the manufacturers of these filters three different times: in 1978, 1979 and 1982. Although important filter specifications were maintained

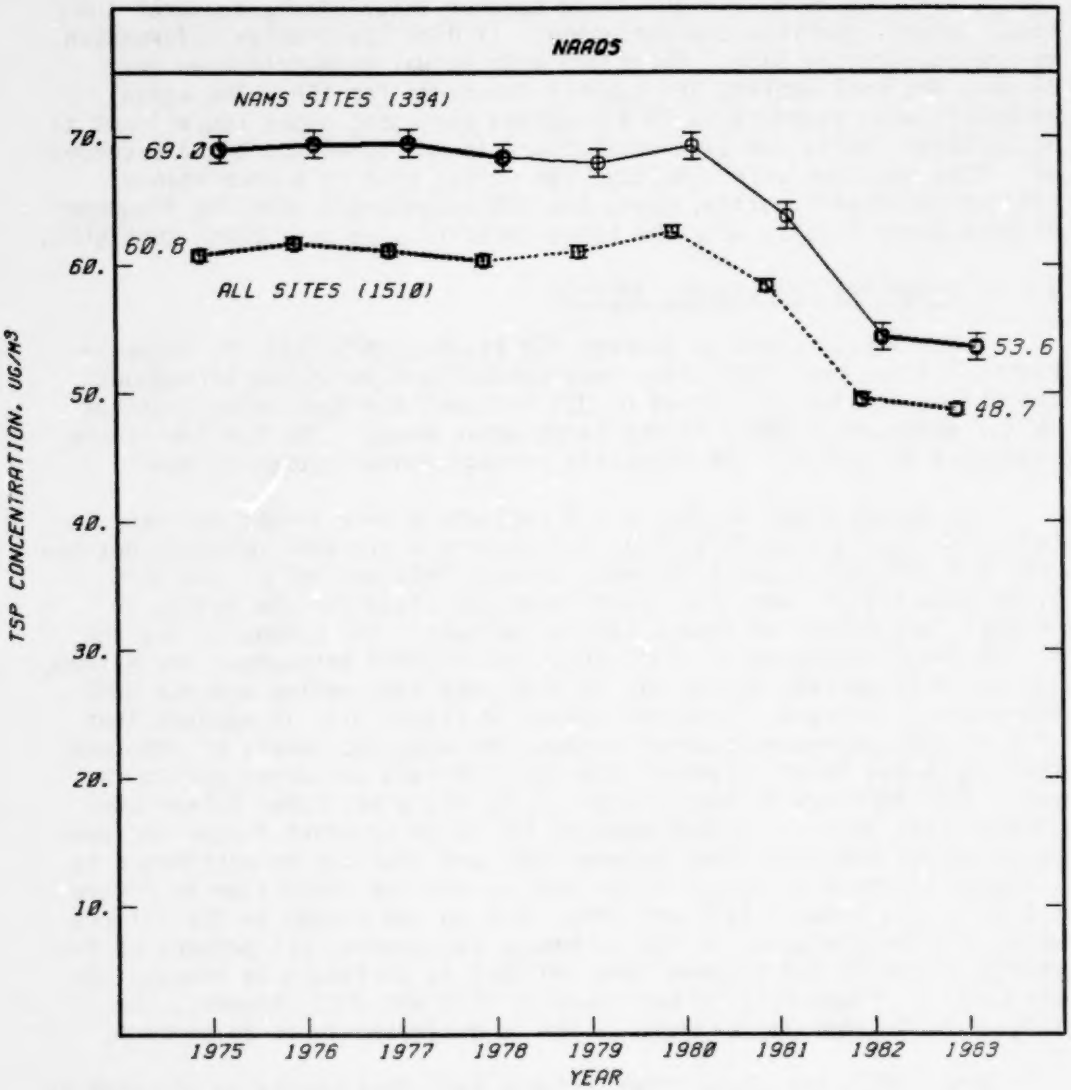


FIGURE 3-3. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE GEOMETRIC MEAN TOTAL SUSPENDED PARTICULATE AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

throughout this period some physical characteristics of the filters varied, which in turn prompted studies by air pollution control agencies to investigate the possible impact of the filter changes on measured TSP concentrations.[10,11] Differences in filter alkalinity, cited by Witz et al.[10] of the California South Coast Air Management District appears to be a plausible explanation for differences in measurements among the different filter manufacturers. Alkalinity, which was not previously included in EPA filters specifications, appears to be a better predictor than the hydrogen ion concentration (pH) of artifact particulate matter formation (such as sulfates, nitrates and possibly organic acids), which would inflate TSP measurements.

Using information on the alkalinity of filters provided for the Nation's monitoring networks from 1977 through 1983, the comparability of TSP measurements during this time period can be determined.[9] Due to high alkalinity in the filters used from 1979-1981, it is reasonable to suspect that TSP levels for the years 1979 through 1981 are biased high relative to the adjacent years. Moreover, the use of similar and less alkaline filters in 1978, 1982 and 1983, all produced by the same manufacturer, suggest that the TSP levels for these years may be compared. The recent trend in TSP levels is therefore discussed in terms of these data.

In order to provide the best estimate of the improvement in TSP between 1978 and 1983, 1378 sites were examined which measured TSP in both years and satisfied the annual data completeness criteria in each year. The composite mean of the 1378 sites decreased 20 percent with a corresponding 20 percent for the subset of NAMS.

Figures 3-3 and 3-4 examine the air quality trend at 1510 sites over the 1975-1983 time period. This was done to evaluate the 1978 and 1983 TSP levels in the context of the 9 year period, which is used for all pollutants. Using 95 percent confidence intervals developed for these data (Figure 3-3), it can be seen that the 1983 levels are significantly lower than those of 1978. Box plots describing change in the distribution of annual means at the 1510 trend sites show a decrease in every percentile level (5, 10, 25, 50, 75, 90, and 95) between 1978 and 1983 (Figure 3-4).

Nationwide TSP emission trends show an overall decrease of approximately 33 percent from 1975 to 1983. (See Table 3-1 and Figure 3-5). Since 1978, however, the particulate matter (PM) emissions have decreased 22 percent which is comparable to the estimated decrease in ambient TSP levels. The trend in PM emissions would not be expected to agree with the trend in ambient TSP levels due to unaccounted for natural PM background and uninventoried emissions sources such as reentrained dust. The apparent agreement between estimates of ambient air quality and emissions may be due in part to the favorable role of meteorology in recent years. An analysis of meteorological conditions for both

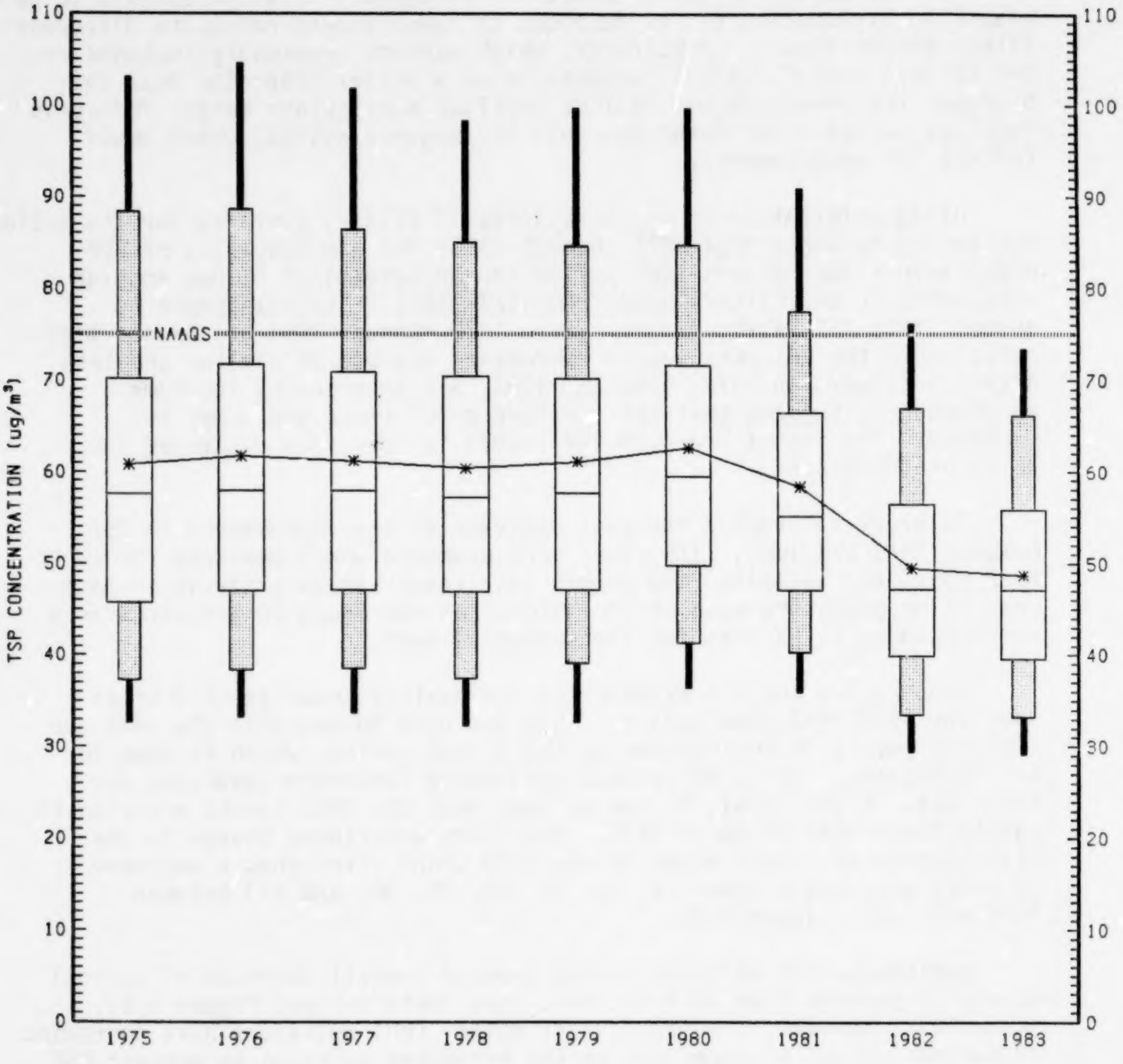


FIGURE 3-4. BOXPLOT COMPARISONS OF TRENDS IN ANNUAL GEOMETRIC MEAN TOTAL SUSPENDED PARTICULATE CONCENTRATIONS AT 1510 SITES , 1975 - 1983.

Table 3-1. National Particulate Emission Estimates, 1975-1983.

(10^6 metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983
Transportation	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3
Fuel combustion	2.6	2.4	2.4	2.3	2.3	2.2	2.2	2.0	2.0
Industrial Processes	5.0	4.4	4.0	4.0	3.8	3.2	2.8	2.4	2.3
Solid Waste & Miscellaneous	1.3	1.4	1.2	1.2	1.3	1.5	1.3	1.1	1.3
Total	10.3	9.6	9.0	8.9	8.8	8.3	7.7	6.8	6.9

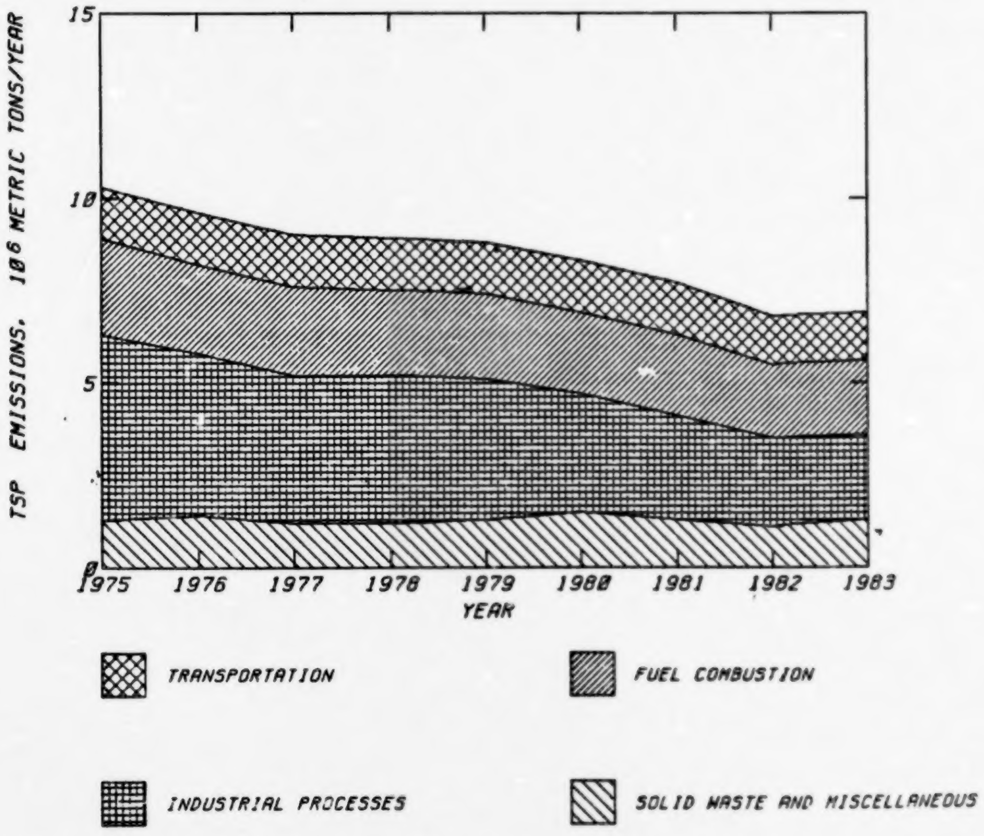


FIGURE 3-5. NATIONAL TREND IN PARTICULATE EMISSIONS, 1975-1983.

1982 and 1983 indicated a potential for lower TSP concentrations due to abnormally high precipitation. This would have had the effect of minimizing fugitive dust entrainment and washing particles out of the air.

The reduction in particulate emissions occurred primarily because of the reductions in industrial processes. This is attributed to a combination of installation of control equipment and reduced industrial activity. Other areas of TSP emission reductions include reduced coal burning by non-utility users and installation of control equipment by electric utilities that burn coal.[7]

3.1.2 Regional Trends

Figure 3-6 shows a comparison of the change in TSP levels by EPA Regions in terms of the 1978 versus 1983 levels. All Regions showed decreases over this time period. The Regions which showed the largest decreases, (III, V, VII, IX, X) either had large reductions in emissions or were affected by favorable meteorology in 1983 or were influenced by a combination of both.

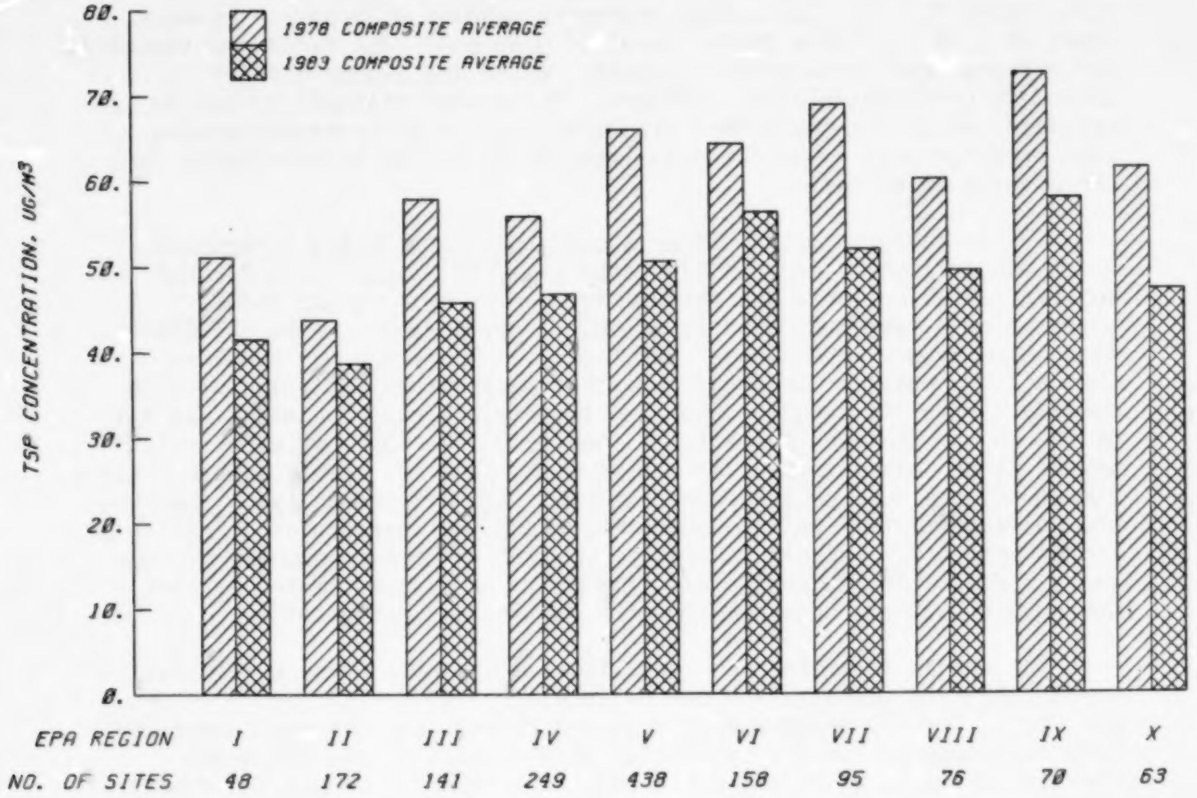


FIGURE 3-6. REGIONAL COMPARISON OF THE 1978 AND 1983 COMPOSITE AVERAGE OF THE GEOMETRIC MEAN TOTAL SUSPENDED PARTICULATE.

3.2 TRENDS IN SULFUR DIOXIDE

Ambient sulfur dioxide (SO_2) results primarily from stationary source coal and oil combustion and from nonferrous smelters. There are three NAAQS for SO_2: an annual arthmetic mean of 0.03 ppm, a 24-hour level of 0.14 ppm and a 3-hour level of 0.50 ppm. The first two standards are primary (health-related) standards, while the 3-hour NAAQS is a secondary (welfare-related) standard. The annual standard is not to be exceeded, while the short-term standards are not to be exceeded more than once per year. The trend analyses which follow are presented for the primary standards.

SO_2 is measured using either a continuous monitoring instrument, which can collect as many as 8760 hourly values a year, or a 24-hour bubbler, which collects one measurement per 24-hour period and is operated on a sampling schedule of once every 6 days. Prior to 1978, most SO_2 monitors were 24-hour bubblers. In 1978, the EPA required that all SO_2 bubblers be modified with a temperature control device to rectify a sampling problem: when the temperature rose too high, not all of the SO_2 present was collected. Therefore, the SO_2 sample collected tended to be underestimated.[12] After 1978, many SO_2 bubblers were retired. Therefore, the bubbler data were not used in the trend analysis, because the instrument modification would complicate the interpretation of the trends analysis. Further, given the bubbler sampling frequency of once every 6 days, the SO_2 peak statistics would be underestimated and not comparable to those obtained from the continuous instruments.

The trends in ambient concentrations are derived from continuous monitoring instruments which can measure as many as 8760 hourly values per year. The SO_2 measurements reported in this section are summarized into a variety of summary statistics which relate to the SO_2 NAAQS. The statistics on which ambient trends will be reported are the annual arithmetic mean concentration, the second highest annual 24-hour average (measured midnight to midnight), and the expected annual number of 24-hour exceedances of the 24-hour standard of 0.14 ppm.

3.2.1 Long-term Trends, 1975-83

The long-term trend in ambient SO_2, 1975-1983, is graphically presented in Figures 3-7 to 3-9. In each figure, the trend at the NAMS is contrasted with the trend at all sites. For each of the statistics presented, a steady downward trend is evident. Nationally, the annual mean SO_2, examined at 286 sites, decreased at a median rate of approximately 5 percent per year; this resulted in an overall change of about 36 percent (Figure 3-7). The subset of 89 NAMS recorded higher average concentrations but declined at a higher rate of 7 percent per year.

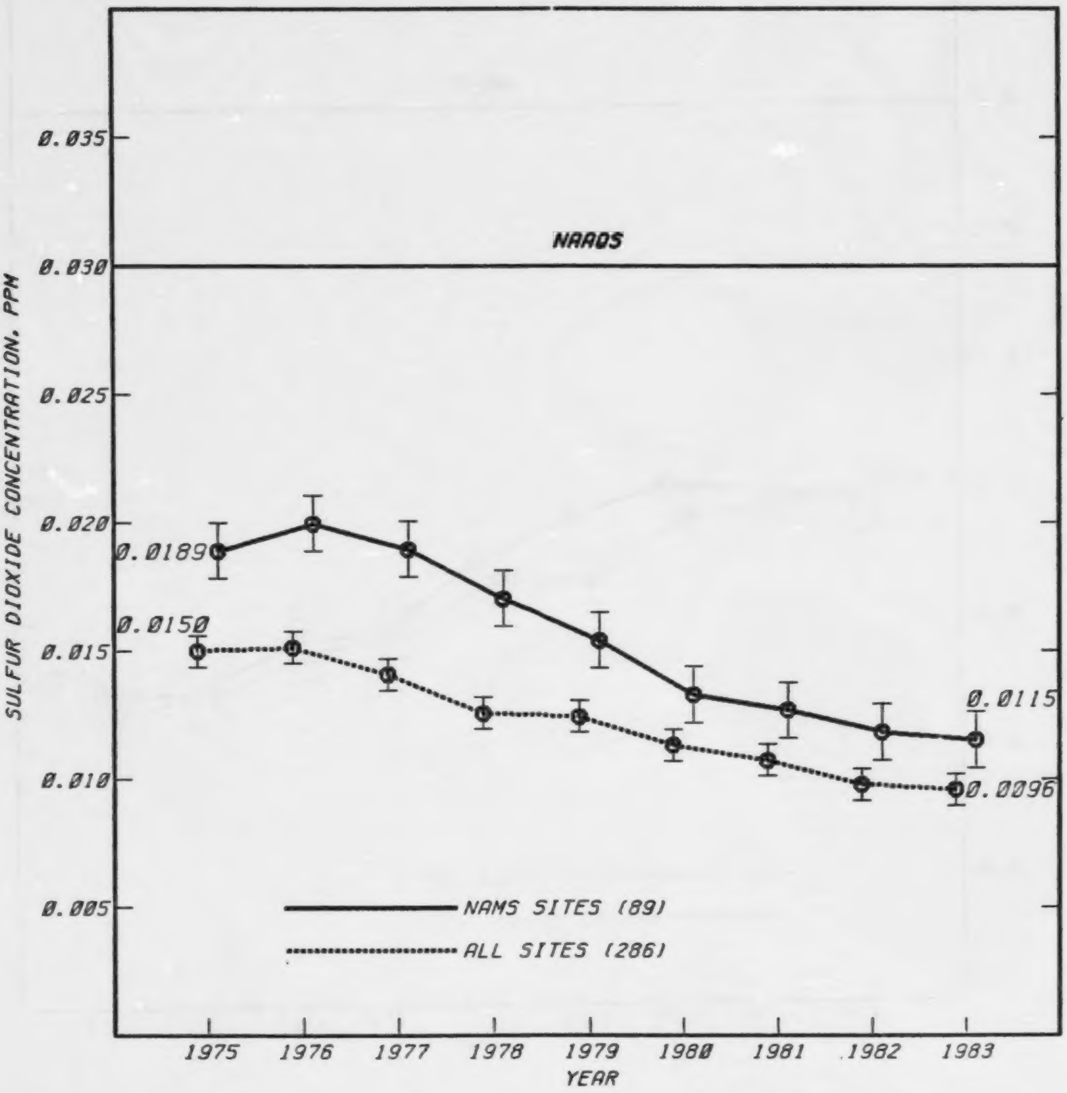


FIGURE 3-7. NATIONAL TREND IN THE ANNUAL AVERAGE SULFUR DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

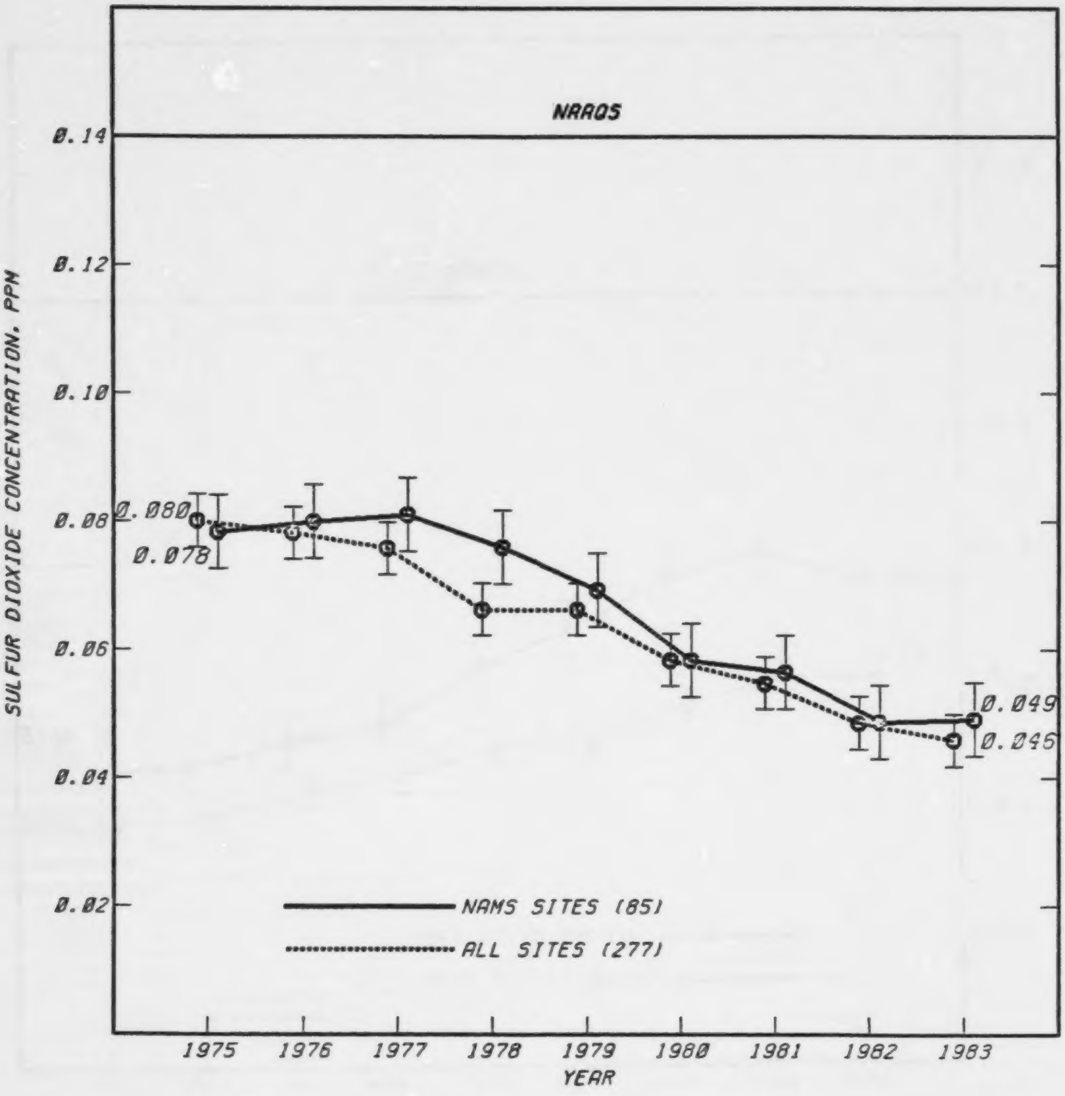


FIGURE 3-8. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND-HIGHEST 24-HOUR SULFUR DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

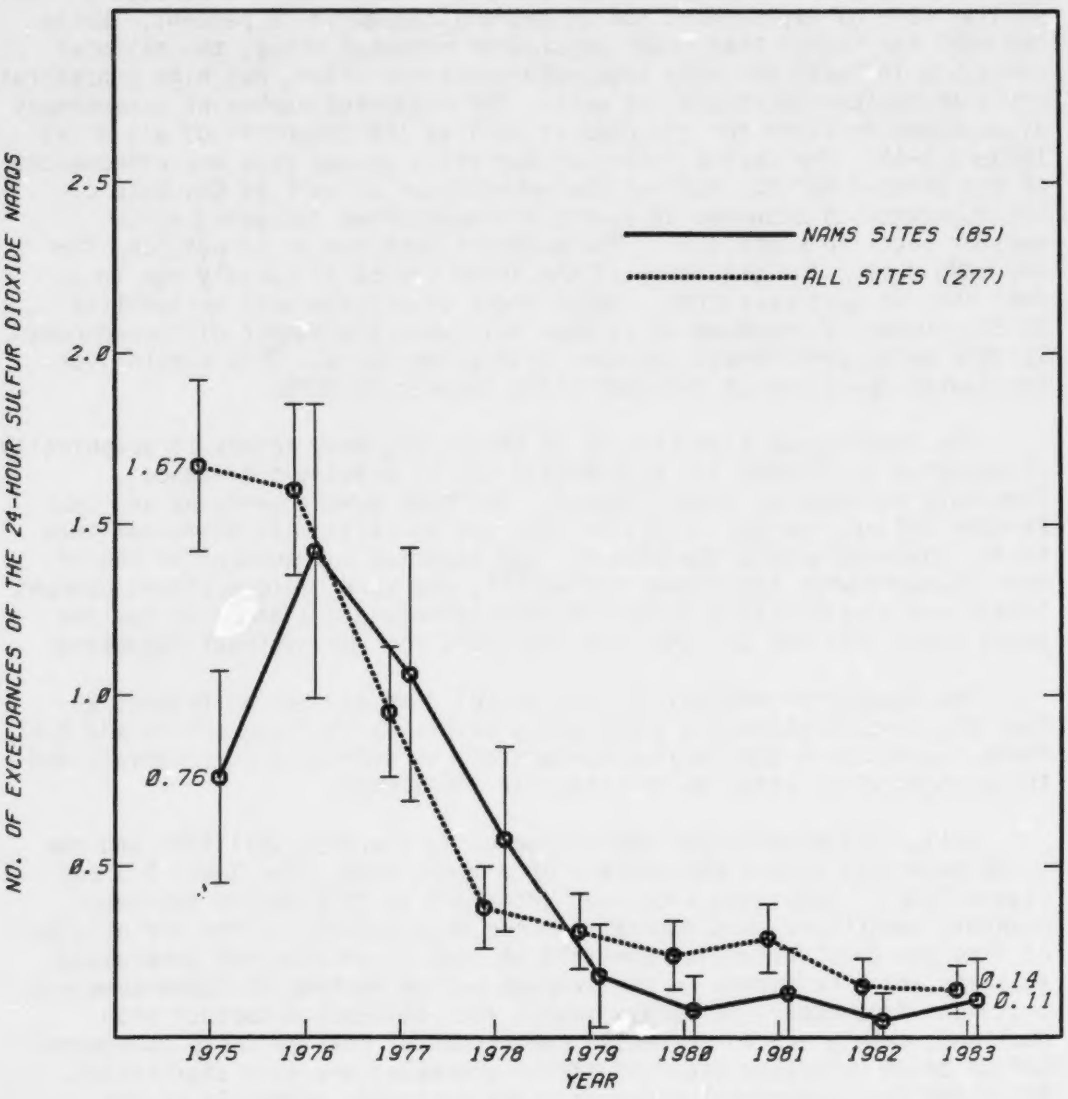


FIGURE 3-9. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE ESTIMATED NUMBER OF EXCEEDANCES OF THE 24-HOUR SULFUR DIOXIDE NAAQS AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS. 1975 - 1983.

The annual second highest 24-hour values displayed a similar decline between 1975 and 1983. Nationally, among 277 stations with adequate trend data, the average rate of change was 6 percent per year with an overall decline of 43 percent (Figure 3-8). The 85 NAMS exhibited a similar rate of improvement for an overall change of 37 percent. While the NAMS are higher than other population oriented sites, the national composite includes not only population-oriented sites, but high concentration sites at smelter locations, as well. The estimated number of exceedances also showed declines for the NAMS as well as the composite of all sites (Figure 3-9). The vast majority of SO_2 sites do not show any exceedances of the 24-hour NAAQS. Most of the exceedances as well as the bulk of the improvements occurred at source oriented sites including a few smelter sites in particular. The apparent increase in exceedances for the NAMS during the beginning of the trend period is largely due to a NAMS site in Salt Lake City, Utah. There is considerable variability in the number of exceedances at this site with the number of exceedances in 1976 being considerably greater than other years. This single site has caused the trend at the NAMS sites to peak in 1976.

The statistical significance of these long-term trends is graphically illustrated on Figures 3-7 to 3-9 with the 95 percent confidence intervals included on these figures. For both annual averages and peak 24-hour values, the SO_2 levels in 1983 are statistically different than levels observed during the 1970's. For expected exceedances of the 24-hour standard with its higher variability and more rapid decline, current levels are statistically different than average exceedances in earlier years (1975-1979 for the NAMS and 1975-1980 for the national composite).

The intra-year variability for annual mean and second highest 24-hour SO_2 concentrations is graphically displayed in Figures 3-10 and 3-11. These figures show that higher concentrations decreased more rapidly and the concentration range among sites has diminished.

Sulfur oxide emissions are dominated by electric utilities and the trend generally tracks the pattern of ambient data. (See Table 3-2 and Figure 3-12). Emissions increased from 1975 to 1976 due to improved economic conditions, but decreased since then reflecting the installation of flue gas desulfurization controls at coal-fired electric generating stations and a reduction in the average sulfur content of fuels consumed. Emissions from other stationary source fuel combustion sectors also declined, mainly due to decreased combustion of coal by these consumers. Sulfur oxide emissions from industrial processes are also significant. Emissions from industrial processes have declined, primarily as the result of controls implemented to reduce emissions from nonferrous smelters and sulfuric acid manufacturing plants.[7]

Nationally, sulfur oxide emissions decreased 19 percent from 1975 to 1983. The difference between emission trends and air quality trends arises because the use of high sulfur fuels was shifted from power plants in urban areas, where most of our monitors are, to power plants

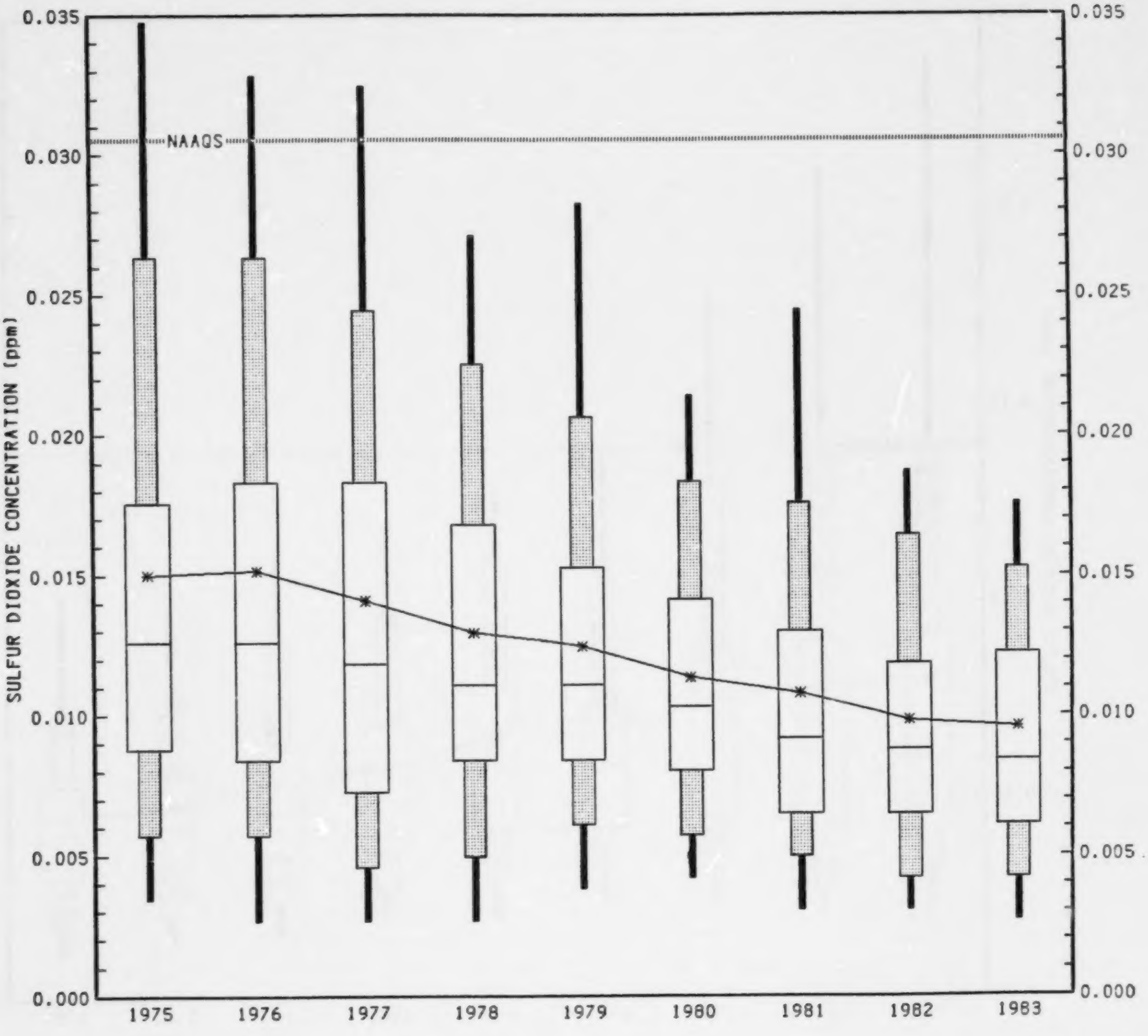


FIGURE 3-10. BOXPLOT COMPARISONS OF TRENDS IN ANNUAL MEAN SULFUR DIOXIDE CONCENTRATION AT 286 SITES, 1975 - 1983.

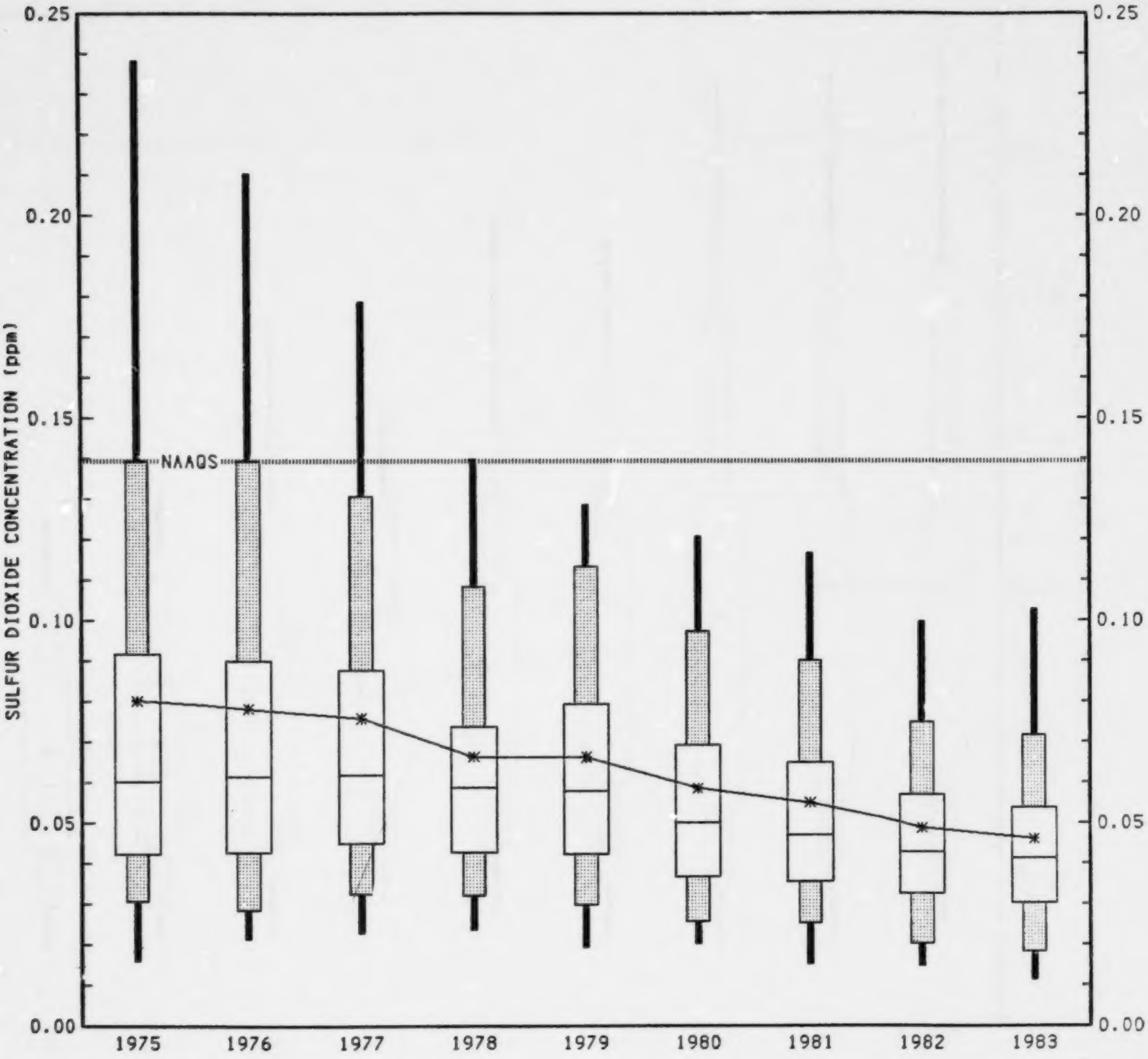


FIGURE 3-11. BOXPLOT COMPARISONS OF TRENDS IN SECOND HIGHEST 24-HOUR AVERAGE SULFUR DIOXIDE CONCENTRATIONS AT 277 SITES, 1975 -1983.

Table 3-2. National Sulfur Oxide Emission Estimates, 1975-1983

(10^6 metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983
Transportation	0.6	0.7	0.8	0.8	0.9	0.9	0.8	0.8	0.9
Fuel Combustion	20.3	20.9	21.1	19.6	19.4	18.8	17.8	17.3	16.8
Industrial Processes	4.7	4.6	4.4	4.1	4.2	3.5	3.7	3.2	3.1
Total	25.6	26.2	26.3	24.5	24.5	23.2	22.3	21.3	20.8

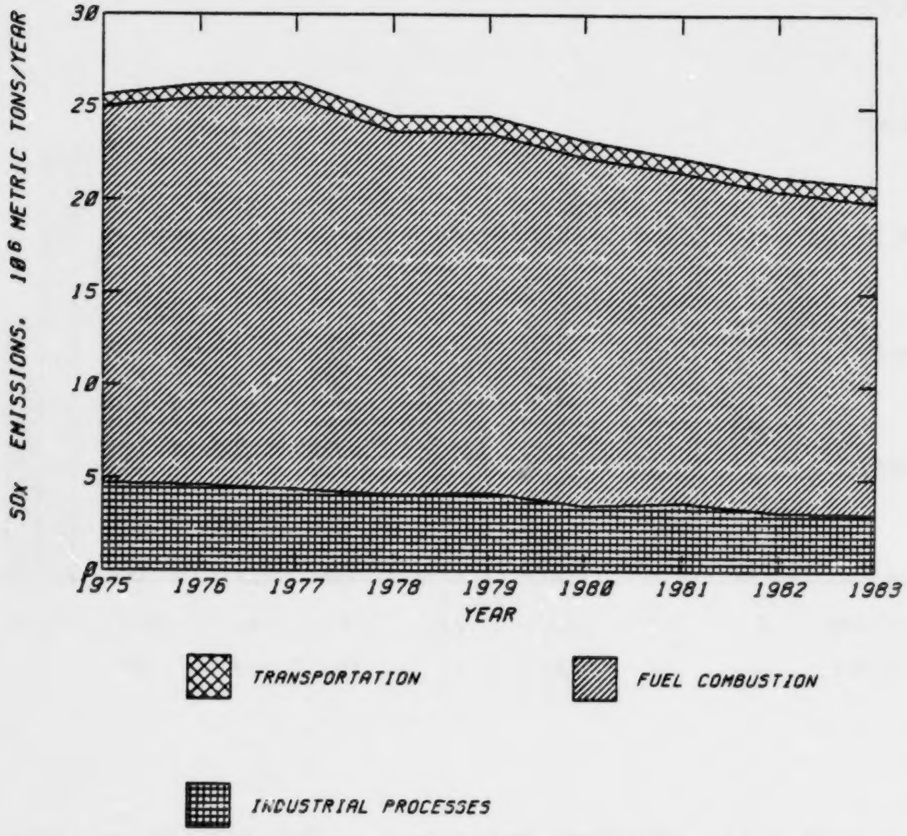


FIGURE 3-12. NATIONAL TREND IN SULFUR OXIDE EMISSIONS, 1975-1983.

in rural areas which have fewer monitors. Further, the residential and commercial areas, where the monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvement. These decreases in sulfur oxide emissions are due to a combination of energy conservation measures and the use of cleaner fuels in the residential and commercial areas.

3.2.2 Regional Trends

The annual mean SO_2 levels decreased in nine EPA Regions from 1975-1983 (Figure 3-13). Only Region VI had a majority of sites increasing over this time period. These sites were primarily monitors located in areas with low SO_2 concentrations. For the second high 24-hour values, the long-term change showed similar patterns.

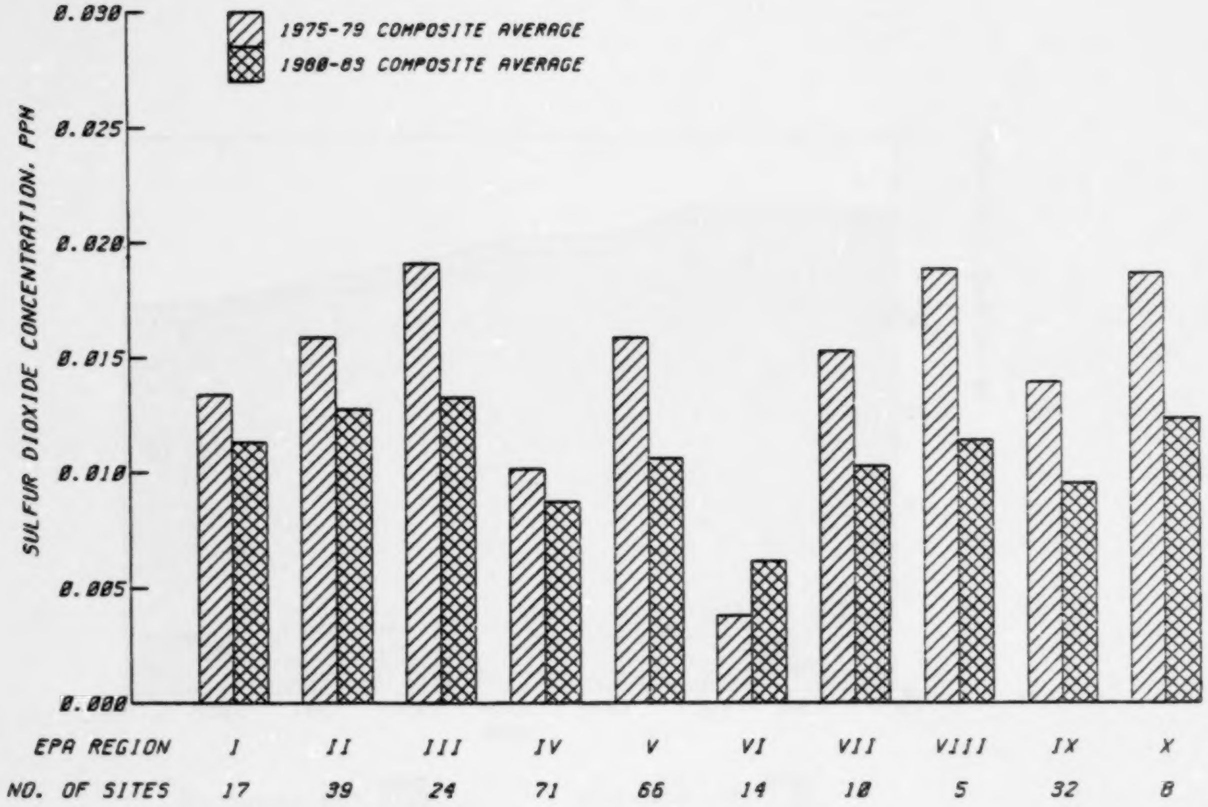


FIGURE 3-13. REGIONAL COMPARISON OF THE 1975-79 AND 1980-83 COMPOSITE AVERAGE OF THE ANNUAL AVERAGE SULFUR DIOXIDE CONCENTRATIONS.

3.3 TRENDS IN CARBON MONOXIDE

Carbon monoxide (CO) is a byproduct of the incomplete burning of fuels. Highway motor vehicles are the largest contributing source of CO emissions. There are both 1-hour and 8-hour NAAQS for ambient CO. The 1-hour average standard specifies a level of 35 ppm not to be exceeded more than once per year while the 8-hour average standard specifies that a level of 9 ppm should not be exceeded during more than one 8-hour period in a year. This section focuses primarily on the 8-hour data because the 8-hour standard is generally more restrictive.

The trends site selection process, discussed in Section 2.1, resulted in a data base of 174 sites for CO for the 1975-83 time period. This includes 42 sites that have been designated as National Air Monitoring Stations (NAMS)

3.3.1 Long-Term Carbon Monoxide Trends: 1975-83

Figure 3-14 illustrates the national 1975-83 composite average trend for the second highest non-overlapping 8-hour CO value for the 174 trend sites and the subset of 42 NAMS sites. The national composite decreased by 33 percent between 1975 and 1983 while the NAMS sites recorded a 31 percent decrease. The median rate of improvement was approximately 5 percent per year with almost 90 percent of the trend sites and the NAMS showing long-term improvement. Between 1982 and 1983, the pattern was more mixed with the national composite showing only a 1 percent improvement. The confidence intervals displayed in Figure 3-14 substantiate this long-term decrease in ambient CO levels with the more recent levels being significantly less than those in earlier years.

Figure 3-15 displays the same trend but the box-plot presentation provides more information on how the distribution of ambient CO levels at the 174 trend sites has changed during the 1975-83 period. The overall long-term improvement is apparent although some year to year departures occur for certain percentiles. While the percent of these trend sites that meet the 8-hour CO standard each year is not explicitly shown, this has improved consistently from year to year with only 35 percent of these 174 sites meeting the standard in 1975 and almost 70 percent meeting the 8-hour standard in 1983. Therefore, while the national trend shows considerable improvement, continued progress needs to be sustained in many areas.

Figure 3-16 presents the composite average trend for the estimated number of exceedances of the 8-hour CO NAAQS which was adjusted to account for incomplete sampling. This statistic is consistent with the long-term improvement, although the decrease is more pronounced with an 87 percent reduction for the average of all 174 sites and a comparable 81 percent decrease for the NAMS.

National carbon monoxide emissions are estimated to have decreased 16 percent between 1975 and 1983 (see Table 3-3 and Figure 3-17). These

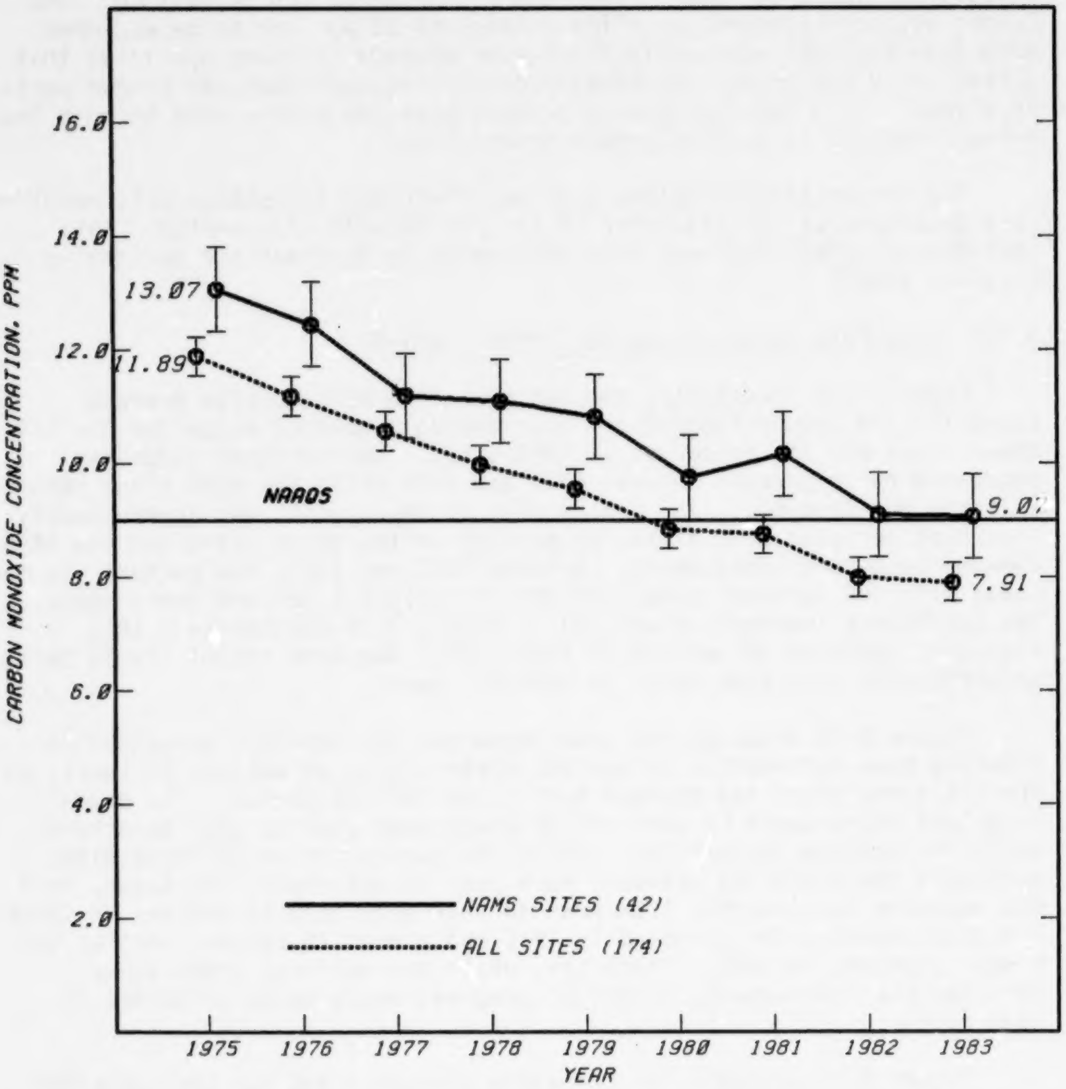


FIGURE 3-14. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND HIGHEST NONOVERLAPPING 8-HOUR AVERAGE CARBON MONOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

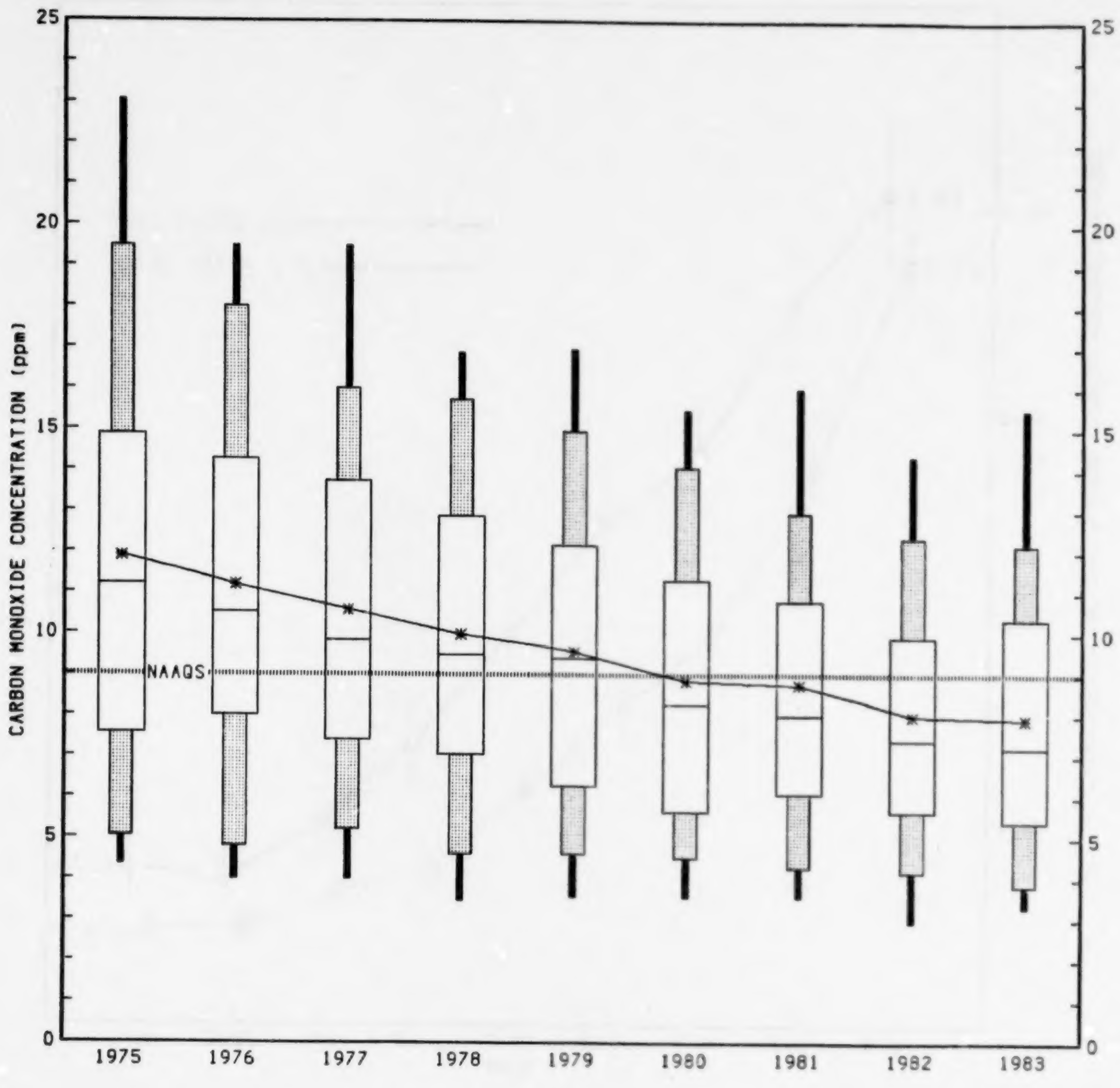


FIGURE 3-15. BOXPLOT COMPARISONS OF TRENDS IN SECOND HIGHEST NONOVERLAPPING 8-HOUR AVERAGE CARBON MONOXIDE CONCENTRATIONS AT 174 SITES, 1975 -1983.

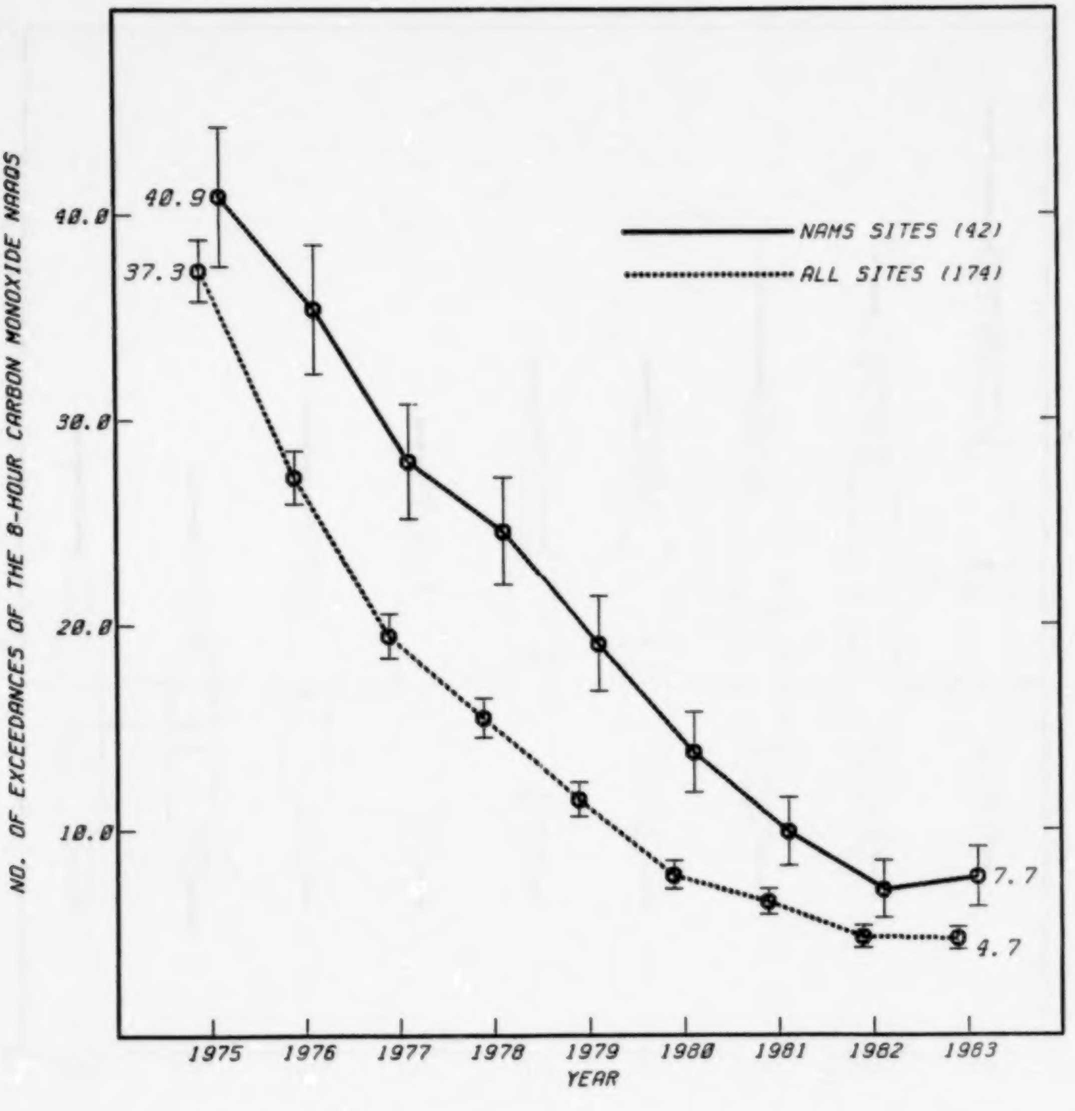


FIGURE 3-16. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE ESTIMATED NUMBER OF EXCEEDANCES OF THE 8-HOUR CARBON MONOXIDE NAAQS AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

Table 3-3. National Carbon Monoxide Emission Estimates, 1975-1983.

(10^6 metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983
Transportation	62.0	64.3	61.1	60.4	55.9	52.7	51.6	48.1	47.7
Industrial Processes	6.9	7.1	7.2	7.1	7.1	6.3	5.9	4.4	4.6
Solid Waste, Fuel Combustion & Miscellaneous	11.6	13.9	12.8	13.1	14.4	16.0	14.8	13.6	15.3
Total	80.5	85.3	81.1	80.6	77.4	75.0	72.3	66.1	67.6

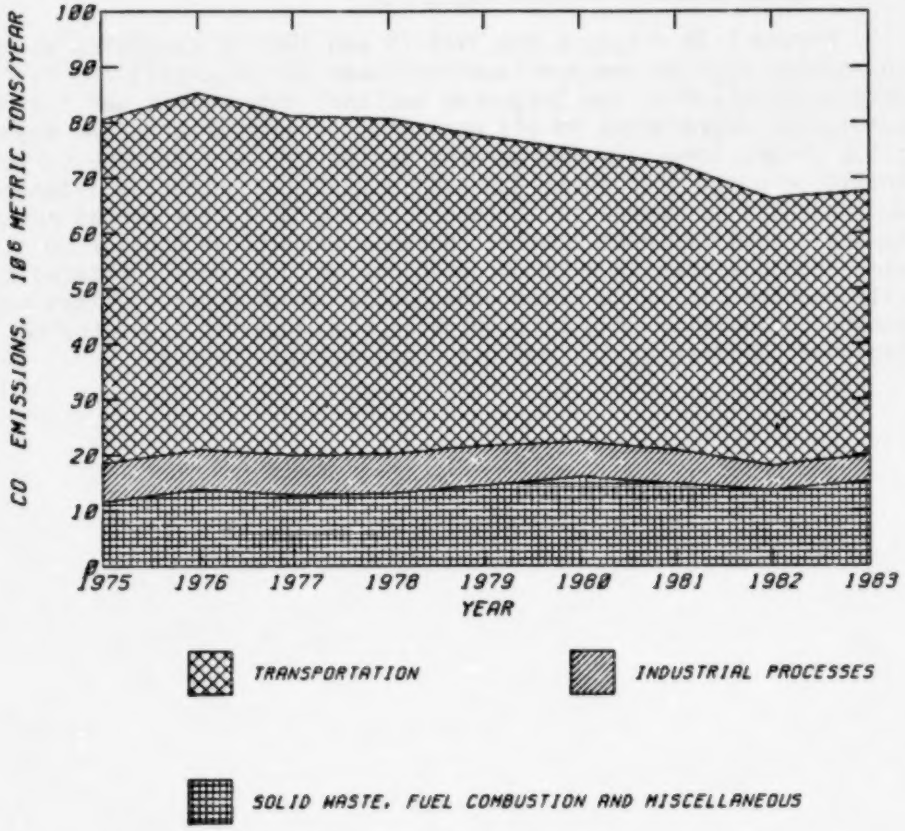


FIGURE 3-17. NATIONAL TREND IN EMISSIONS OF CARBON MONOXIDE, 1975-1983.

emission trend estimates show an increase between 1975 and 1976 followed by year to year decreases from 1977 through 1982. However, 1983 reflects a reversal with total CO emissions increasing 2 percent between 1982 and 1983. Transportation sources are the major contributor to CO emissions accounting for approximately 70 percent of the national total in 1983. During the 1975-83 period, CO emissions from transportation sources decreased 23 percent and showed a 1 percent decrease between 1982 and 1983 even though vehicle miles of travel increased 4 percent between 1982 and 1983. This means that the reduction in CO emissions per vehicle mile was sufficient to offset the 1982-83 increase in vehicle miles of travel.

As noted in earlier reports,[13,14] the percent decrease in national average ambient CO levels has typically been larger than the percent decrease in CO emissions. Because CO monitors are typically located to identify potential problems, they are more likely to be placed in traffic saturated areas that are less likely to experience significant increases in vehicle miles of travel. The rate of improvement in ambient CO levels shown in Figure 3-14 slowed between 1982 and 1983 with only a 1 percent decrease in the national average which is consistent with the relatively small change in transportation CO emissions between these 2 years.

3.3.2 Regional Carbon Monoxide Trends

Figure 3-18 displays the 1975-79 and 1980-83 composite averages of the second highest non-overlapping 8-hour CO concentrations by EPA Region. This indicates that the long-term national improvement was the result of consistent improvement in all Regions. In each Region, the majority of sites showed long-term improvement during the 1975-83 time period. It should be noted that these Regional graphs are primarily intended to depict relative change in CO levels during this time period rather than typical levels in each Region. Because the mix of monitoring sites may vary from one area to another, with one set of sites dominated by center-city monitors in large urban areas while another set of sites may represent a more diversified mix, this graph is not intended to be indicative of Regional differences in absolute concentration levels.

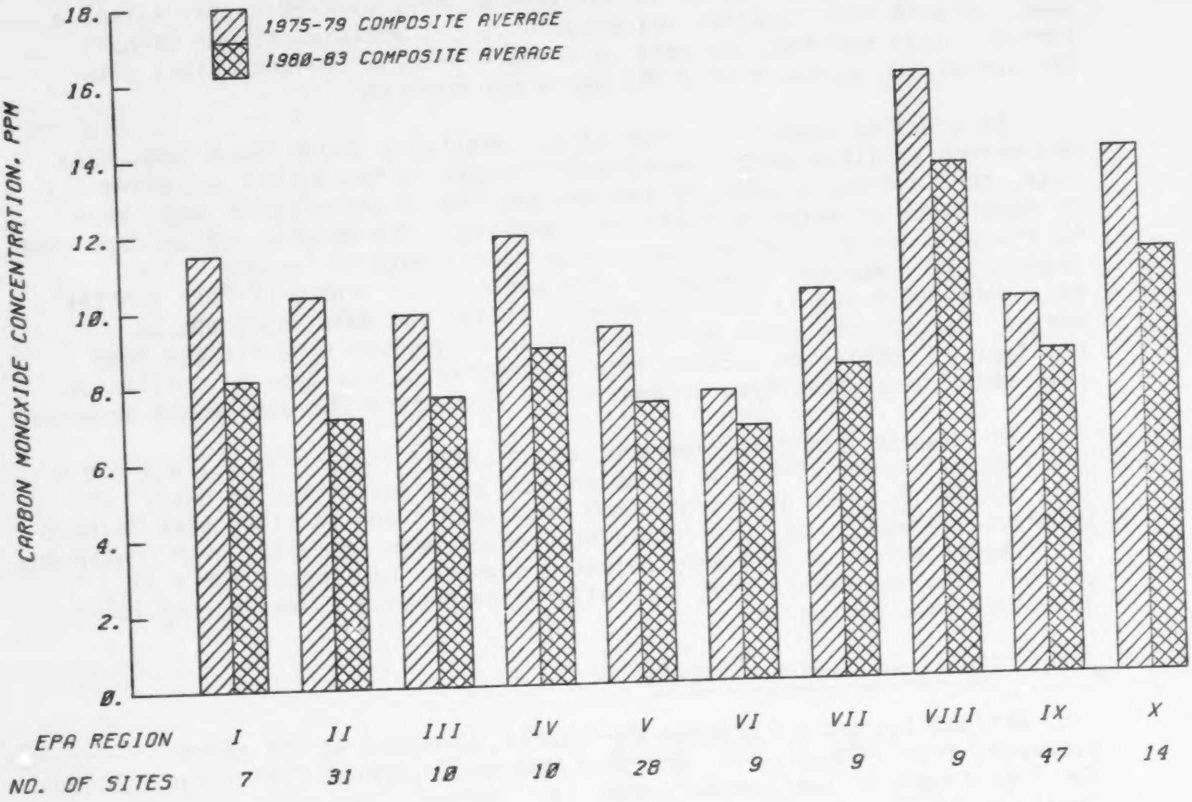


FIGURE 3-18. REGIONAL COMPARISON OF THE 1975-79 AND 1980-83 COMPOSITE AVERAGE OF THE SECOND-HIGHEST NON-OVERLAPPING 8-HOUR CARBON MONOXIDE CONCENTRATION.

3.4 TRENDS IN NITROGEN DIOXIDE

Nitrogen dioxide (NO_2), a yellowish, brown gas, is present in urban atmospheres through emissions from two major sources: transportation and stationary fuel combustion. NO_2 is measured using either a continuous monitoring instrument, which can collect as many as 8760 hourly values a year, or a 24-hour bubbler, which collects one measurement per 24-hour period. Both monitors are used to compare average concentrations with the annual NO_2 standard of 0.053 parts per million.

In order to expand the size of the available trends data base, data was merged at sites which experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as population oriented or duplicate sampling. The merging was accomplished by treating the bubbler and continuous hourly data separately. For example, if a monitor at a given site was changed from a 24-hour bubbler to a continuous hourly monitor or vice versa, the data would not be merged. If, on the other hand, a monitor at a given site changed from one type of bubbler to another type of bubbler or one type of continuous instrument to another type of continuous instrument the data would be merged.

The trends site selection process described in Section 2.1 yielded a total of 177 trend sites, 14 of which have been designated as NAMS. Of this total, 82 sites used continuous instruments and 95 sites used 24-hour bubblers. Finally, all California NO_2 annual means recorded with continuous instruments prior to 1980 were adjusted downward to account for a 14 percent bias associated with the calibration procedure used during the 1975-1980 time period.[15]

3.4.1 Long-term Trends: 1975-83

Nationally, annual average NO_2 levels, measured at 177 sites, increased from 1975 to 1979, and then decreased through 1983 (Figure 3-19). The 1983 composite average NO_2 level is 6 percent lower than the 1975 level, indicating a slight downward trend between 1975 and 1983. The trend pattern in the estimated nationwide emissions of nitrogen oxides is similar to the NO_2 air quality trend with nitrogen oxides emissions increasing from 1975 through 1979 and decreasing thereafter (see Table 3-4 and Figure 3-20).

In Figure 3-19, the 95 percent confidence intervals about the composite means of the 177 sites allow for comparisons among the years. While there are no significant differences among the years for the NAMS, because there are so few monitors satisfying the historical trends criteria, there are significant differences among the composite means of the 177 trend sites (Figure 3-19). Although the 1982 and 1983 composite mean NO_2 levels for the 177 sites are not significantly different from one another, they are significantly less than the earlier years 1978, 1979 and 1980. Figure 3-19 illustrates that there has been a statistically significant decrease in NO_2 levels between 1979 and 1983.

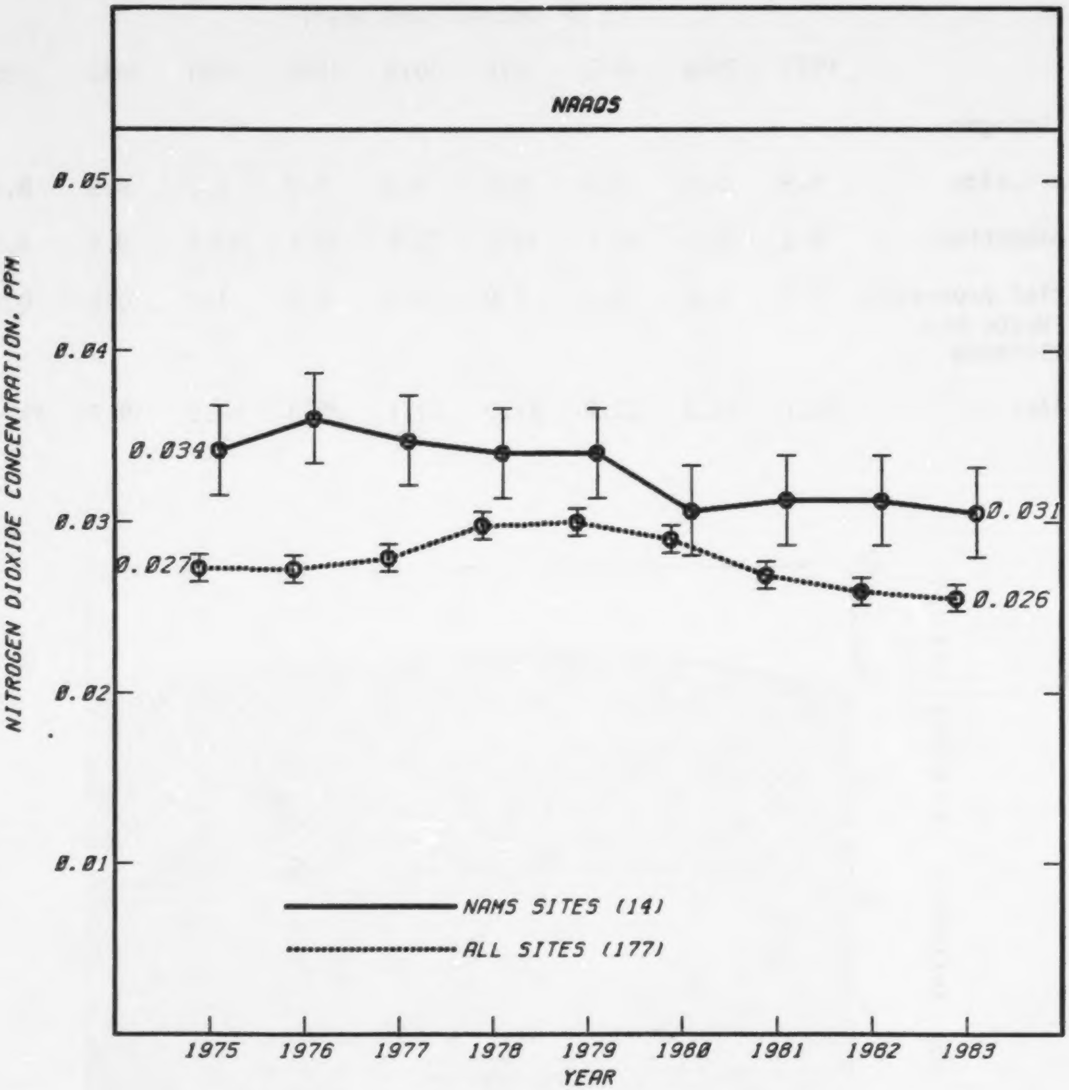


FIGURE 3-19. NATIONAL TREND IN THE COMPOSITE AVERAGE OF NITROGEN DIOXIDE CONCENTRATION AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

Table 3-4. National Nitrogen Oxide Emission Estimates, 1975-1983.

(10^6 metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983
Transportation	8.9	9.3	9.5	9.7	9.6	9.2	9.3	8.9	8.8
Fuel Combustion	9.3	10.0	10.4	10.3	10.5	10.1	10.2	9.9	9.7
Industrial Processes, Solid Waste and Miscellaneous	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.9
Total	19.1	20.3	20.9	21.0	21.1	20.3	20.5	19.6	19.4

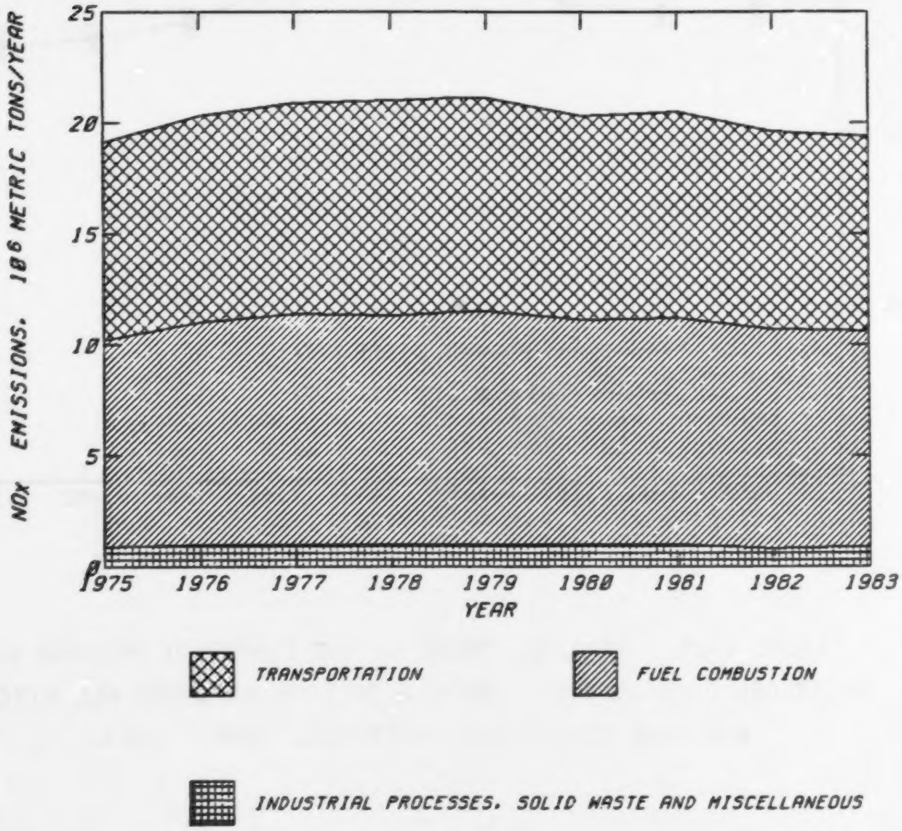


FIGURE 3-20. NATIONAL TREND IN EMISSIONS OF NITROGEN OXIDES. 1975-1983.

Figure 3-21 presents the NO_2 air quality trend with the use of boxplots. The improvement seen in the composite average concentration between 1979 and 1983 is also reflected across the upper percentiles. The lower percentiles, however, show little or no change. Between 1979 and 1983, both NO_2 composite averages and oxides of nitrogen emissions decreased by 15 and 8 percent, respectively.

3.4.2 Regional Trends

Figure 3-22 shows the regional trends in the composite average NO_2 concentrations at the 177 trend sites for two time periods: 1975-79 and 1980-83. Six regions showed decreases in the 1980-83 time period while two regions showed increases. Sites in Regions I and X did not meet the long-term trends selection criteria due to monitoring method changes, i.e. replacement of 24-hour bubblers with continuous monitoring instruments.

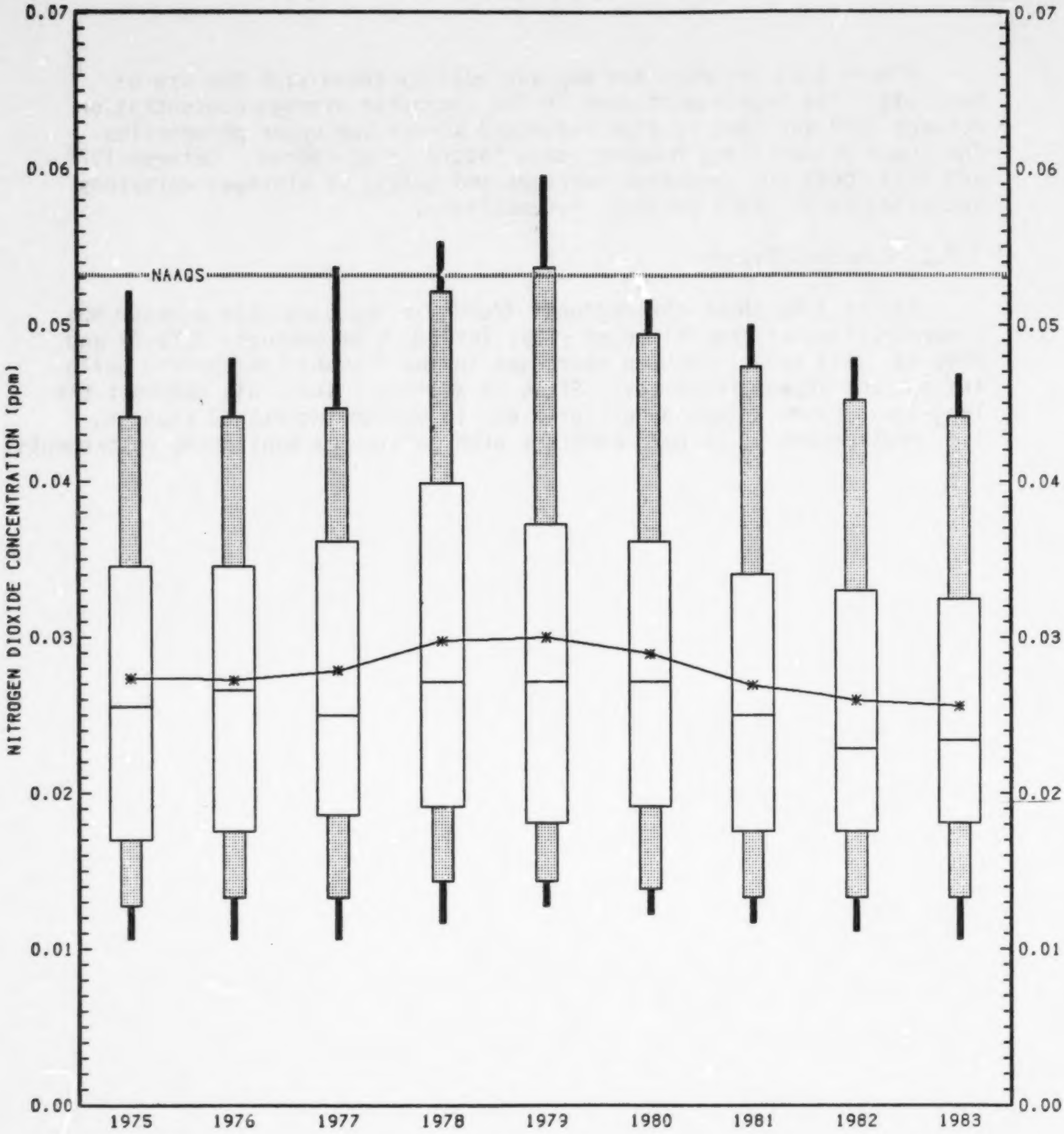


FIGURE 3-21. BOXPLOT COMPARISONS OF TRENDS IN ANNUAL MEAN NITROGEN DIOXIDE CONCENTRATIONS AT 177 SITES, 1975 - 1983.

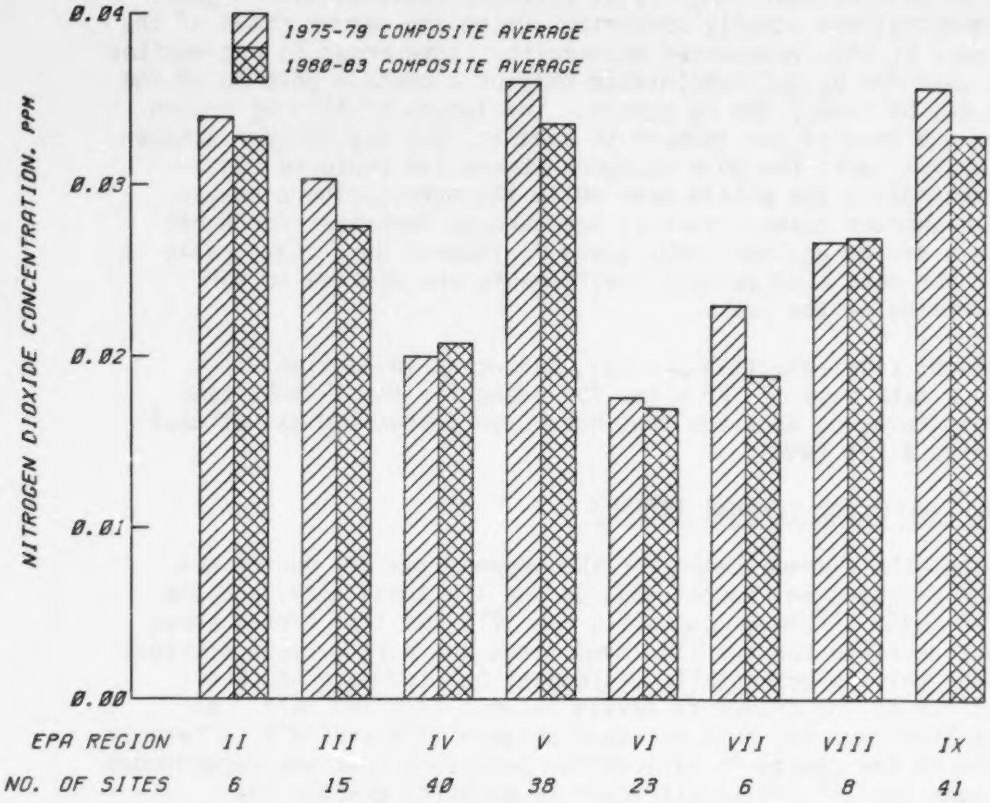


FIGURE 3-22. REGIONAL COMPARISON OF THE 1975-79 AND 1980-83 COMPOSITE AVERAGE OF NITROGEN DIOXIDE CONCENTRATIONS.

3.5 TRENDS IN OZONE

The NAAQS for ozone (O_3) is defined in terms of the daily maximum, that is, the highest hourly value for the day, and specifies that the expected number of days per year with values greater than 0.12 ppm should not be greater than one. O_3 is strongly seasonal with higher ambient concentrations usually occurring during the warmer times of the year. Because of this pronounced seasonality, some areas do not monitor the entire year for O_3 but concentrate only on a certain portion of the year which may be termed the O_3 season. The length of this O_3 season varies from one area of the country to another, but May through October is fairly typical with the more southern states and those in the southwest monitoring the entire year while the more northern states would have a shorter season, such as May through September for North Dakota. This trends analysis uses these O_3 seasons on a state basis to ensure that the data completeness requirements are applied to the relevant portions of the year.

The trends site selection process, discussed in Section 2.1, resulted in a data base of 176 sites for ozone for the 1975-83 time period. This includes 62 sites that have been designated as National Air Monitoring Sites (NAMS).

3.5.1 Long-Term Ozone Trends: 1975-83

The composite average trend for the second high day during the ozone season is shown in Figure 3-23 for the 176 trend sites and the subset of 62 NAMS. Although comparing the 1975 and 1983 levels shows an 8 percent decrease for the 176 trend sites and a 12 percent decrease for the NAMS, this is potentially misleading because most of this decrease is due to the change in levels between 1978 and 1979. As noted in earlier reports, this decrease between 1978 and 1979 is largely attributable to the change in calibration procedure that was recommended by EPA in June 1978.[16] It is difficult to quantify exactly how much of the 1978-79 decrease is due to the calibration change and therefore comparisons with the 1978 and earlier data should be viewed with caution. In focusing on the 1979 and more recent data in Figure 3-23, it is apparent that after two relatively low years, 1981 and 1982, the ozone levels in 1983 have returned to the levels recorded in 1979 and 1980. In fact, the national average for 1983 falls midway between the 1979 and 1980 values. Figure 3-24 uses box-plots to display the same data and illustrates that the entire distribution shifted upward in 1983 returning to the range recorded in 1979-80. The trend in estimated exceedances for ozone is shown in Figure 3-25. This is basically the average number of days during the ozone season that the level of the ozone standard was exceeded. Again, it is apparent that the 1983 levels increased, with the average for the national sample of 176 sites falling between the 1979 and 1980 levels and the NAMS actually being 10 percent higher. As with the other pollutants, the percent change for estimated exceedances is more pronounced than for the second highest value; while the national sample showed a 12 percent increase between 1982 and 1983 for the second highest day, the estimated number of exceedances increased from 5.7 to 8.3 days, or 46 percent.

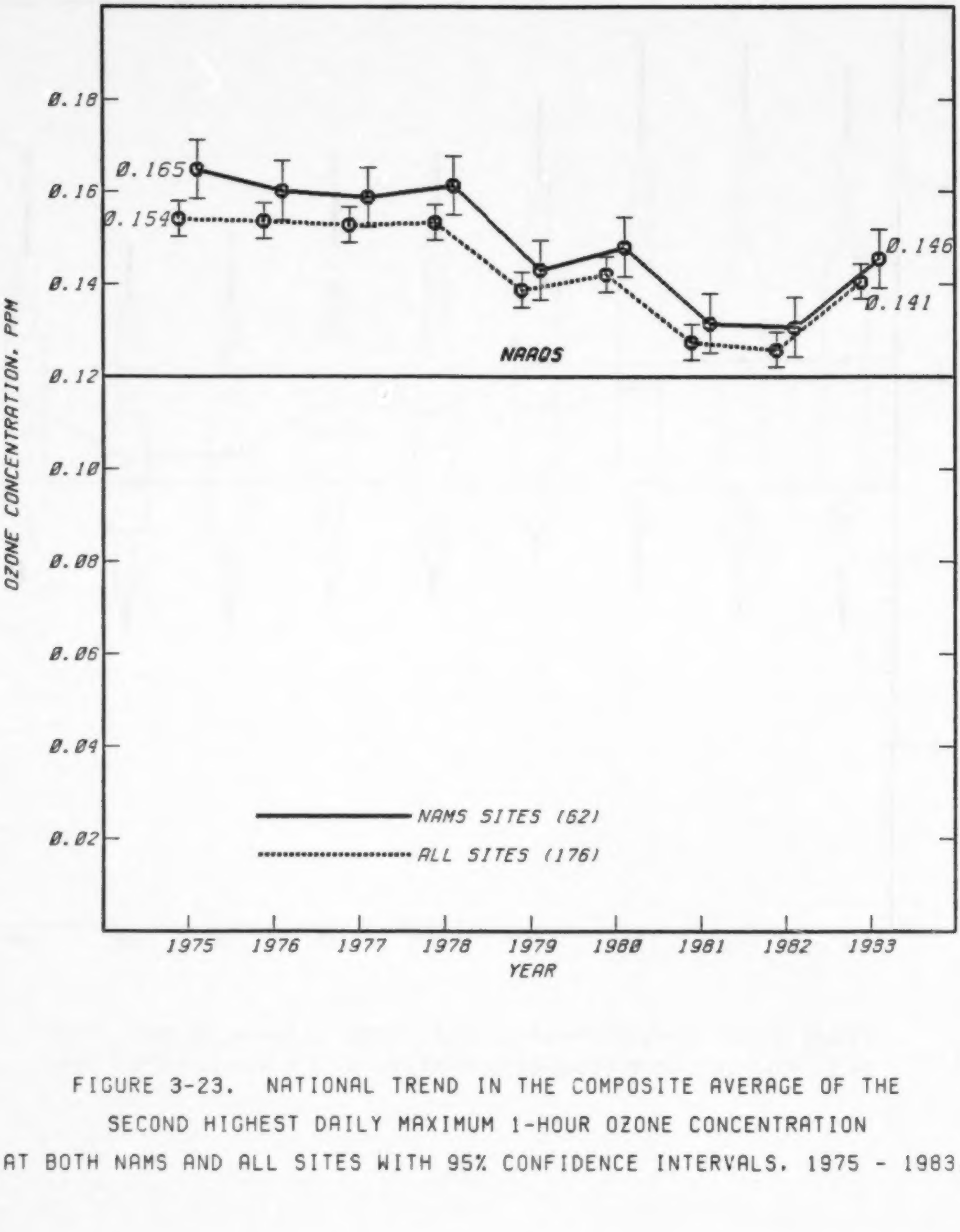


FIGURE 3-23. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE SECOND HIGHEST DAILY MAXIMUM 1-HOUR OZONE CONCENTRATION AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

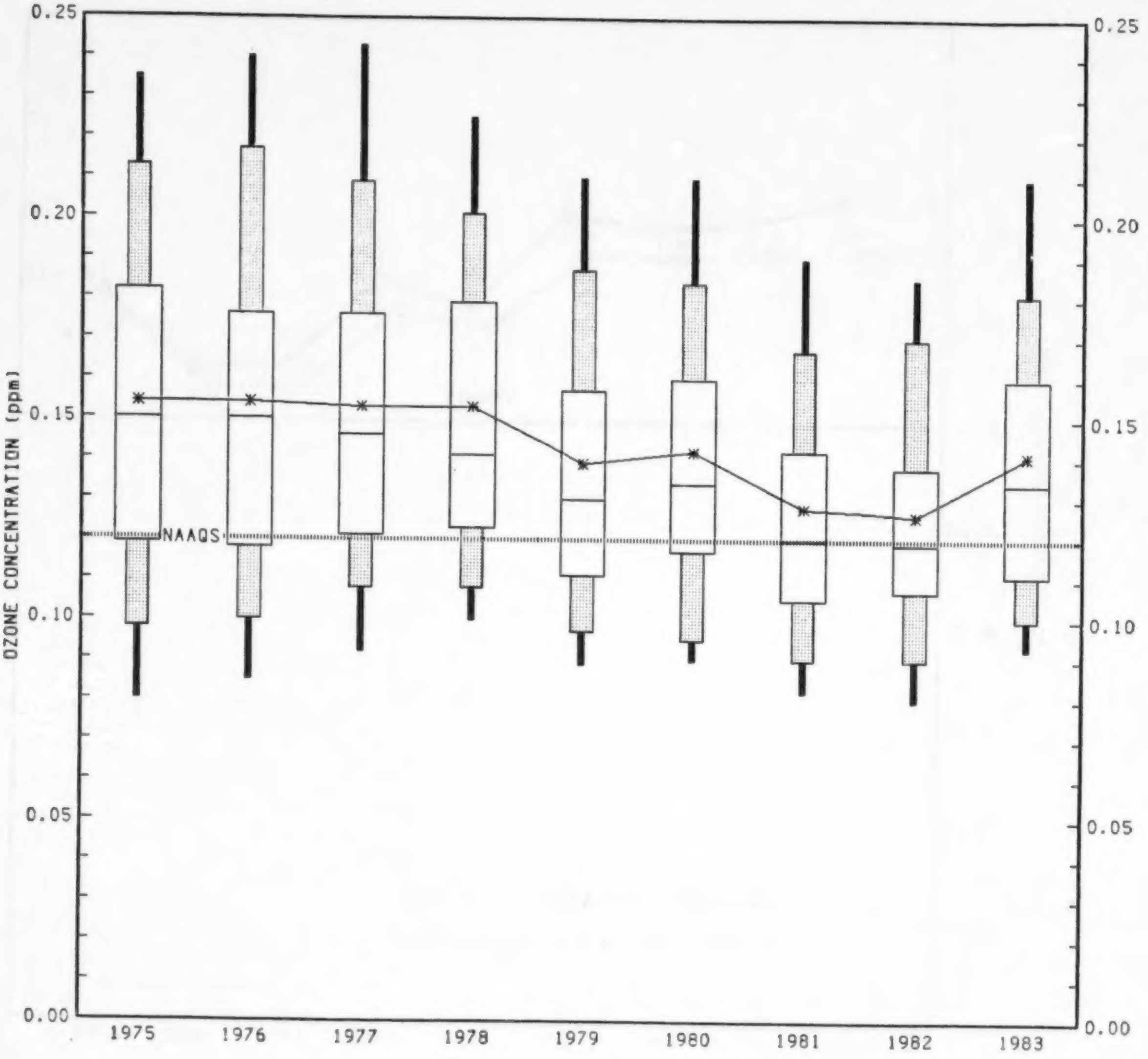


FIGURE 3-24. BOXPLOT COMPARISONS OF TRENDS IN ANNUAL SECOND HIGHEST DAILY MAXIMUM 1-HOUR OZONE CONCENTRATIONS AT 176 SITES, 1975 - 1983.

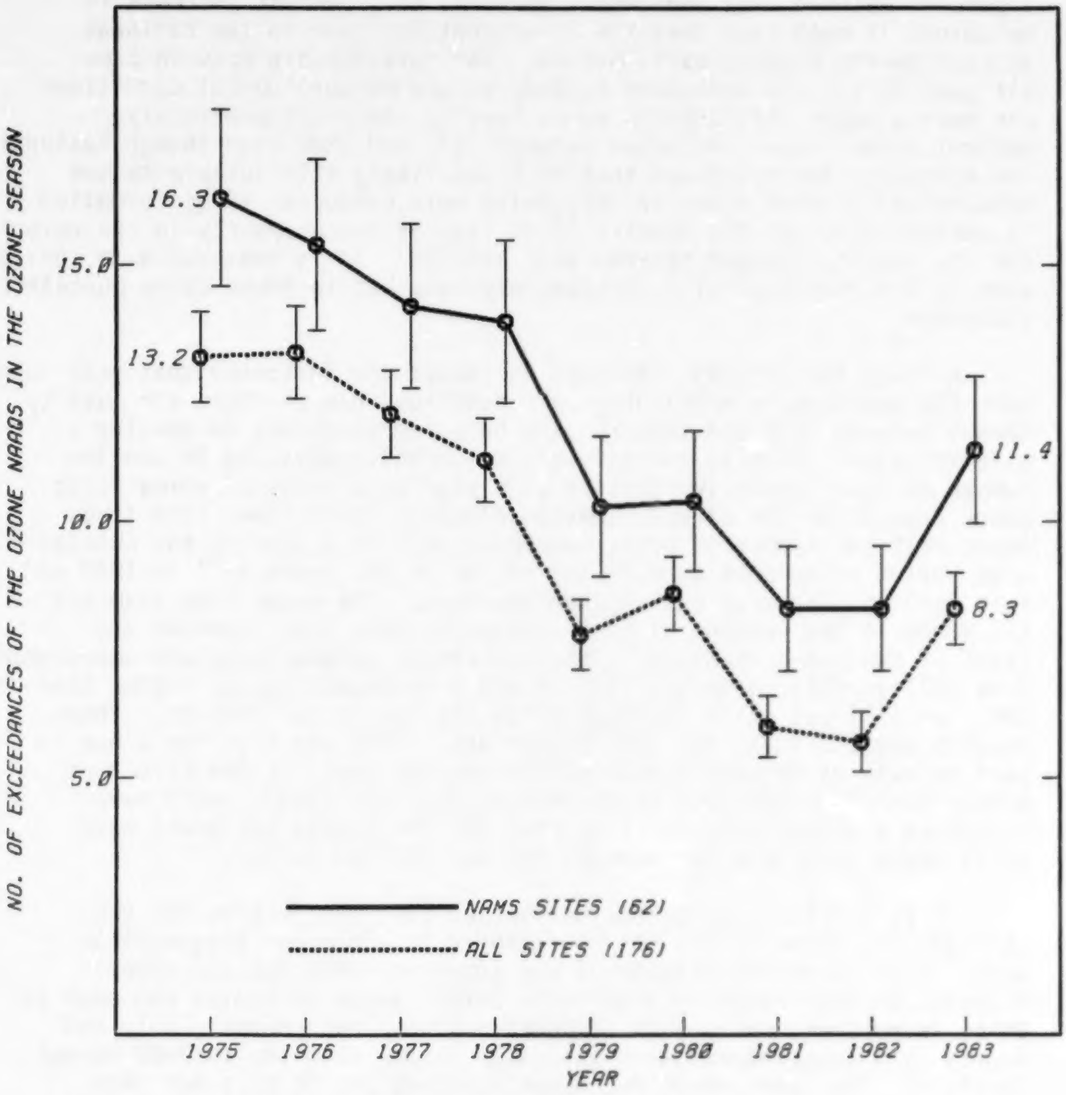


FIGURE 3-25. NATIONAL TREND IN THE COMPOSITE AVERAGE OF THE ESTIMATED NUMBER OF DAILY EXCEEDANCES OF THE OZONE NAAQS IN THE OZONE SEASON AT BOTH NAMS AND ALL SITES WITH 95% CONFIDENCE INTERVALS, 1975 - 1983.

Table 3-5 and Figure 3-26 display the 1975-83 emission trends for Volatile Organic Compounds (VOC) which, along with nitrogen oxides, are involved in the atmospheric chemical and physical processes that result in the formation of O_3. The estimated total for 1983 is 12 percent lower than in 1975 but total VOC emissions are estimated to have increased 3 percent between 1982 and 1983. However, this percent increase in emissions is much less that the 12 percent increase in the national average second highest daily maxima. The relationship between ozone air quality and VOC emissions is complex and meteorological conditions can have a major influence on ozone levels. As noted previously, ambient ozone levels increased between 1979 and 1980 even though national VOC emissions decreased and that this was likely attributable to the meteorological conditions in 1980 being more conducive to O_3 formation in certain parts of the country.[14] In view of the disparity in the emission and air quality changes between 1982 and 1983, it is reasonable to consider what role meteorological conditions may have had in these ozone concentration increases.

A study in Illinois attempted to reduce the influence that year to year fluctuations in meteorological conditions had on ozone air quality trends between 1977 and 1983.[17] The basic approach was to develop a meteorological index to identify ozone conducive days and to use the number of ozone conducive days in each year as a means of normalizing ozone trends for the effect of meteorological conditions. The study found that the number of ozone conducive days in a year in the Chicago area varied by as much as a factor of two in the years 1977 to 1983 and that 1983 had the most ozone conducive days. The study also examined the trend in the percent of ozone conducive days that exceeded the level of the ozone standard. This percentage showed long-term improvement from 1977 to 1983, although 1983 showed a reversal and was higher than 1981 and 1982 but still remained below the levels for 1977-80. These results suggest that, for the Chicago area, 1983 was high for ozone in part because of meteorological conditions and that, if the effect of meteorological conditions were removed, the 1983 levels would have reflected a slight deterioration from 1981-82 levels but would have still shown long-term improvement for the 1977-83 period.

It is difficult to determine whether this explanation for the Chicago area ozone trends can be extended to a broader geographical area. A study of the climate of the summer of 1983 for the Upper Midwest, an area reaching from North Dakota south to Kansas and east to Ohio, found that, while June temperatures were near normal, July and August 1983 temperatures were generally higher than the 1950-80 normal levels.[18] This same study found that cooling degree days for 1983 were 50 percent greater than normal over about one-third of this 12-state region and that electrical demand in 1983, affected by both air conditioning and irrigation needs, was generally higher than 1982 with increases of 14-25 percent being common. However, this does not quantitatively evaluate the impact of meteorology on ozone trends.

It would be ideal to explain the national ozone trends in terms of a national ozone potential index based upon the prevailing meteorological condition. Because of the complexity of the ozone problem, such an

Table 3-5. Volatile Organic Compound National Emission Estimates, 1975-1983.

	(10^6 metric tons/year)								
	1975	1976	1977	1978	1979	1980	1981	1982	1983
Source Category									
Transportation	10.3	10.4	10.0	9.8	8.9	8.2	8.0	7.5	7.2
Industrial Processes	8.1	8.7	9.0	9.6	9.5	8.9	8.0	7.1	7.5
Solid Waste, Fuel Combustion and Miscellaneous	2.4	2.8	2.7	2.9	3.1	3.3	3.4	3.3	3.6
Nonindustrial Organic Solvent Use	1.9	1.9	1.9	1.9	2.0	1.9	1.6	1.5	1.6
Total	22.7	23.8	23.6	24.2	23.5	22.3	21.0	19.4	19.9

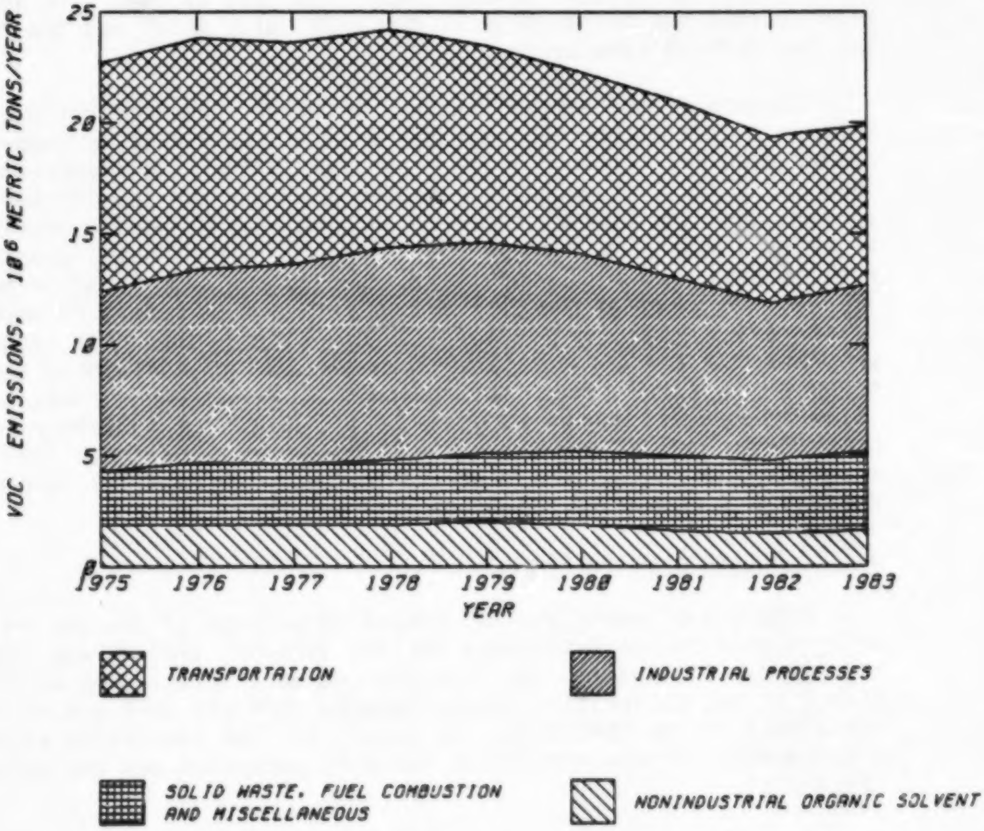


FIGURE 3-26. NATIONAL TREND IN EMISSION OF VOLATILE ORGANIC COMPOUNDS, 1975-1983.

index has not been developed and it is probably debatable whether it would be possible to construct such an index. The meteorological conditions that describe an ozone conducive day in one area may not be applicable for another area. However, to at least provide more insight on the ozone trend, a simplified index was considered using meteorological information on maximum daily temperature, average 8AM-1PM cloud cover below 20,000 feet and average 8AM-1PM wind speed. The meteorological data was obtained from the National Climatic Data Center for ten different cities: New York, Philadelphia, Atlanta, Cincinnati, St. Louis, Houston, Minneapolis, Denver, Los Angeles, and Portland. Ambient ozone data from nearby monitoring sites were used to determine site-specific cut-off values for the meteorological variables. The yearly results for each site were normalized by dividing by the long-term 1979-83 average for that site and then the yearly value of the national composite was obtained by averaging across the ten cities. Obviously, this approach to a national ozone meteorological index is overly simplistic. In fact, for any particular city the index is likely to be inadequate but, by normalizing the index for each city, the relative change from year to year may be useful. The final results showed that the index was low for 1981 and 1982 suggesting that ozone levels would be lower. However, 1979 was just as low. The index was high in 1983 but not as high as the 1980 value which was the highest for the 1979-83 time period.

Because of the simplifications involved, the meteorological interpretation of the national trend should be viewed as suggestive rather than definitive. It is clear that ozone levels increased between 1982 and 1983. Based upon a detailed analysis for the Chicago area, it appears that the 1982-83 increase in that area is partly attributable to meteorological conditions and, if the effect of meteorological conditions were removed, the 1983 ozone levels would show deterioration between 1982 and 1983 but would still be consistent with long-term improvement. Based upon a simplified national meteorological index for ozone, it is possible, but not certain, that the same factors influenced the national ozone trend. Therefore, the magnitude of the ozone increase nationally (i.e. 12 percent) may be accentuated by the effect of meteorology. However, in view of the estimated emission increases, the 1983 ozone levels likely reflect deterioration between 1982 and 1983 and ozone remains as a pervasive pollution problem.

3.5.2 Regional Ozone Trends

Figure 3-27 contrasts the composite average of the second highest daily 1-hour O_3 concentrations for the 1979-80, 1981-82 and 1983 ozone seasons by EPA Region. The time periods were selected to avoid the effect of the calibration change between 1978 and 1979 and to highlight the effect of the 1983 data. As shown, all but one Region experienced a short-term increase in 1983. The only exception was the northwest (Region X).

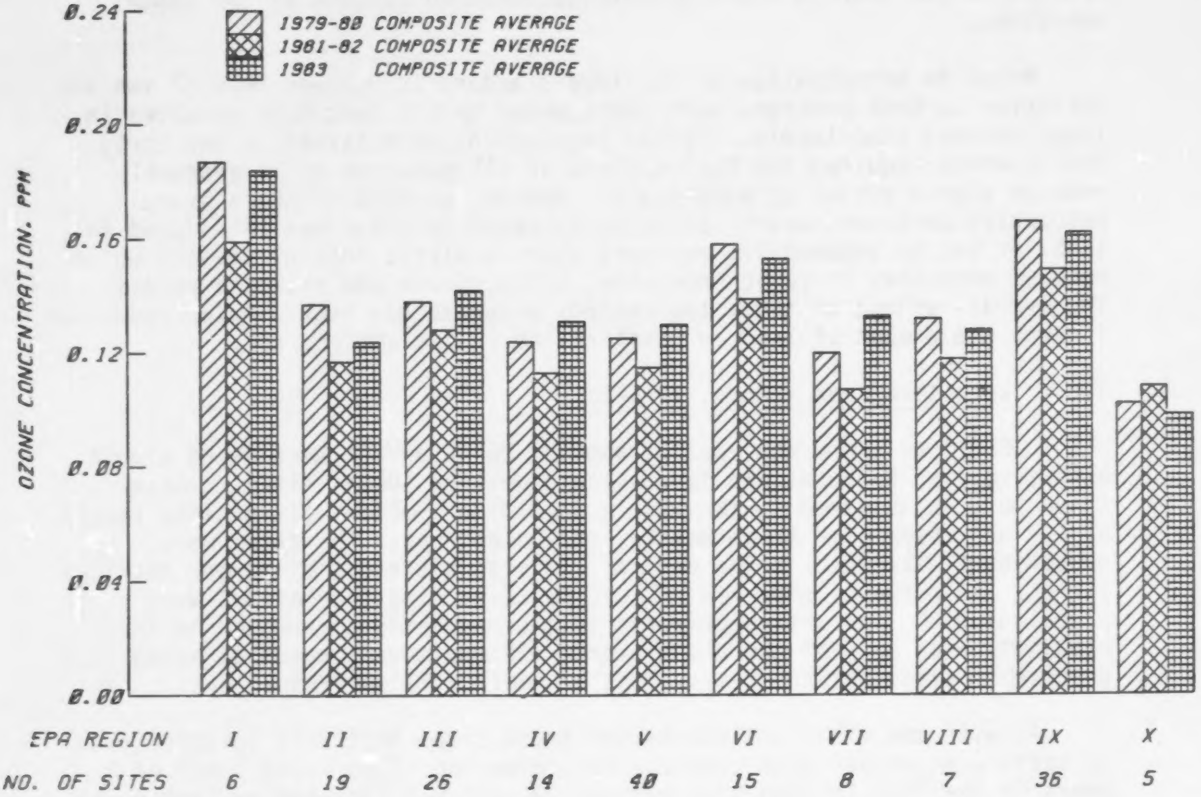


FIGURE 3-27. REGIONAL COMPARISON OF THE 1979-80, 1981-82, AND 1983 COMPOSITE AVERAGE OF THE SECOND-HIGHEST DAILY 1-HOUR OZONE CONCENTRATION.

3.6 TRENDS IN LEAD

Lead (Pb) gasoline additives, non-ferrous smelters, and battery plants are the most significant contributors to atmospheric lead emissions. Transportation sources alone contribute about 80 percent of the annual emissions.

Prior to promulgation of the lead standard in October 1978,[19] two air pollution control programs were implemented by EPA that have resulted in lower ambient lead levels. First, regulations were issued in the early 1970's which required the lead content of all gasoline to be gradually reduced over a period of many years. Second, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices which reduced emissions of carbon monoxide, hydrocarbons and nitrogen oxides. The overall effect of these two control programs has been a major reduction in both the amount of lead in gasoline and in the ambient air.

3.6.1 Long-term Lead Trends, 1975-83

Previous trend analyses of ambient Pb data[20,21] were based almost exclusively on National Air Surveillance Network (NASN) sites. These sites were established in the 1960's to monitor ambient air quality levels of TSP and associated trace metals, including lead. The sites were predominantly located in the central business districts of larger American cities. In October 1980, new ambient Pb monitoring regulations were promulgated.[22] The siting criteria in the regulations resulted in the elimination of many of the old historic TSP monitoring sites as being unsuitable sites for the measurement of ambient Pb concentrations.

As with the other pollutants the trend sites that were selected had to satisfy an annual data completeness criterion of at least 7 out of 9 years in the 1975 to 1983 time period. A year was included as "valid" if at least 3 of the 4 quarterly averages were available. A total of only 61 urban-oriented sites, representing just ten states, met the data completeness criteria. Twenty-four of the trend sites were located in the State of Texas. A total of 138 sites satisfied a trend criteria for the 1980-83 period.

The mean of the composite maximum quarterly averages and their respective 95 percent confidence intervals are shown in Figure 3-28 for both 61 urban sites (1975-1983) and 138 sites (1980-1983). There was a 67 percent overall (1975-83) decrease. The confidence intervals indicate that the 1975-79 averages are significantly different from the 1980-83 averages. The decrease was 34 percent in the mean (1980-83) for both the 61 sites or the larger sample of 138 sites. The box plots are shown in Figure 3-29 for the 1975-83 period. All percentiles basically show the same overall downward pattern as the mean. The lower percentiles (10 and 25th) primarily reflect sites located in Texas.

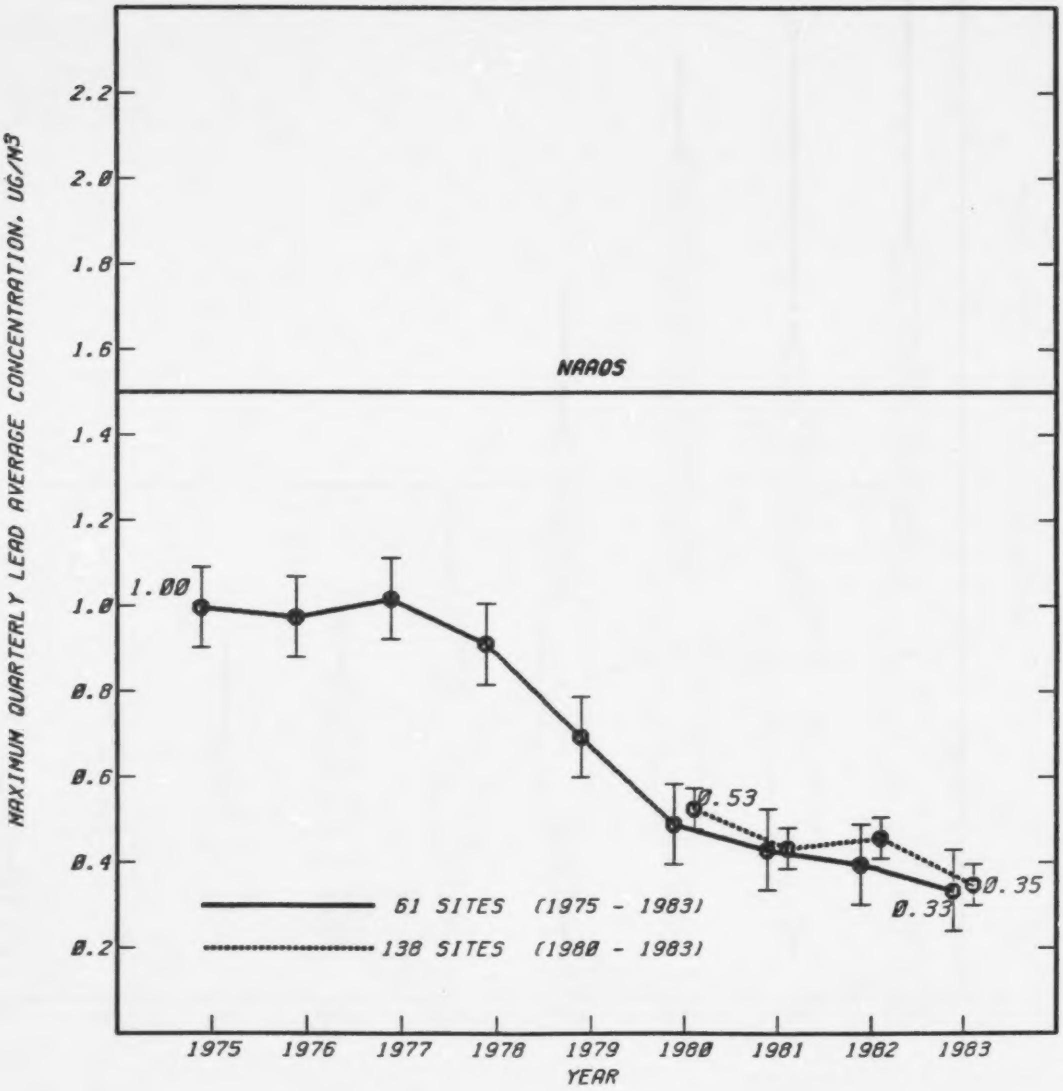


FIGURE 3-28. NATIONAL TREND IN MAXIMUM QUARTERLY AVERAGE LEAD LEVELS WITH 95% CONFIDENCE INTERVALS AT 61 SITES (1975 - 1983) AND 138 SITES (1980 - 1983).

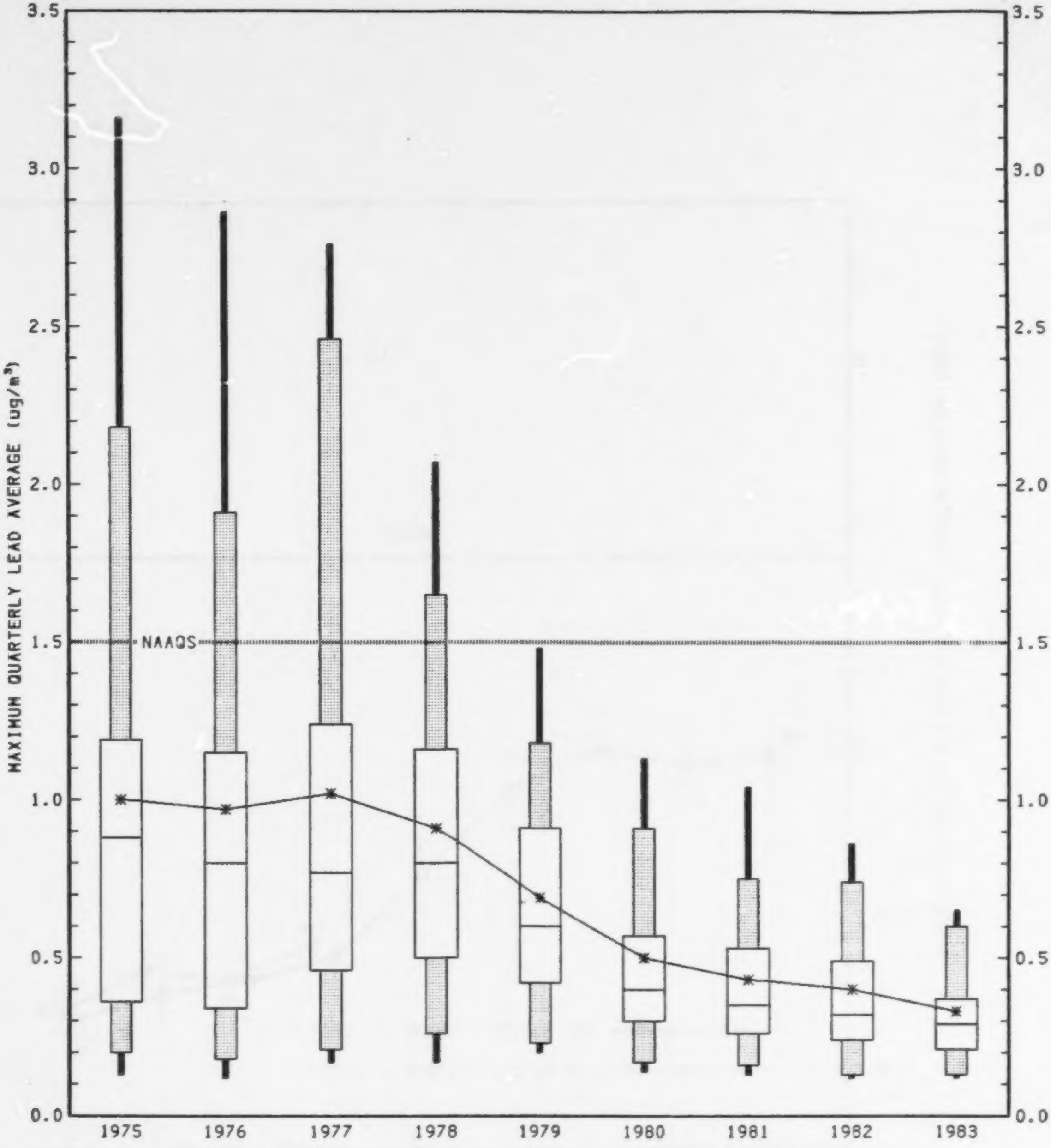


FIGURE 3-29. BOXPLOT COMPARISONS OF TRENDS IN MAXIMUM QUARTERLY LEAD LEVELS AT 61 SITES, 1975 - 1983.

The 1975-83 trends in total lead emissions and lead used as a gasoline additive, based on information respectively from the National Emissions Data System[7] and the Ethyl Corporation[23] are shown in Figures 3-30 and 3-31, respectively. Table 3-6 summarizes the lead emissions data as well. The drop (1975-83) in lead emissions was 68 percent while lead used in gasoline dropped 75 percent. This compares with a 67 percent decrease (1975-83) in ambient lead noted above. The drop in lead consumption since 1975 was brought about because of the increased use of unleaded gasoline in catalyst equipped cars and the reduced lead content in other gasoline. In 1983 unleaded gasoline sales represented 54 percent of the total gasoline sales. Although the good agreement between the trend in lead consumption, emissions, and ambient levels may be more fortuitous than real due to the imbalanced national sample of trend sites, it does show that ambient urban Pb levels are responding to the drop in lead emissions.

Ambient Pb trends were also studied over the shorter term period 1980-83 (Figure 3-32). A total of 138 urban sites from 28 states met the minimum data requirement of at least 3 out of the 4 years of data. This larger and more representative set of sites showed an improvement of 34 percent over this time period. This corresponds to reductions in lead emissions and lead consumption in gasoline of 34 and 45 percent, respectively. Even this larger group of sites was disproportionately weighted by sites in Arizona, California, Minnesota, Pennsylvania, and Texas. These five states accounted for 52 percent of the 138 sites represented. Ambient lead levels have decreased in each of these five states. Also shown is the Pb trend at the 10 NAMS represented in the sample of 138 trend sites. The Pb trend at the NAMS sites is similar to the trend for the entire sample although the average maximum Pb levels are higher, because NAMS sites are located in areas of maximum Pb emissions. Interestingly, the decrease in ambient lead levels is so pronounced, that the 10 NAMS, while few in number, show statistically significant decreases with the 1981 and 1982 composite averages significantly less than the 1979 and 1980 composite averages.

Table 3-6. National Lead Emission Estimates, 1975-1983

	(10^3 metric tons/year)								
	1975	1976	1977	1978	1979	1980	1981	1982	1983
Source Category									
Transportation	122.6	132.4	124.2	112.4	94.6	59.4	46.4	46.9	40.7
Fuel Combustion	9.3	8.3	7.2	6.1	4.9	4.0	2.8	1.7	0.6
Industrial Process	10.3	8.1	5.7	5.4	5.2	3.6	3.0	2.7	2.5
Solid Waste	4.8	4.3	4.1	4.0	4.0	3.7	3.7	3.1	3.1
Total	147.0	153.1	141.2	127.9	108.7	70.7	55.9	54.4	46.9

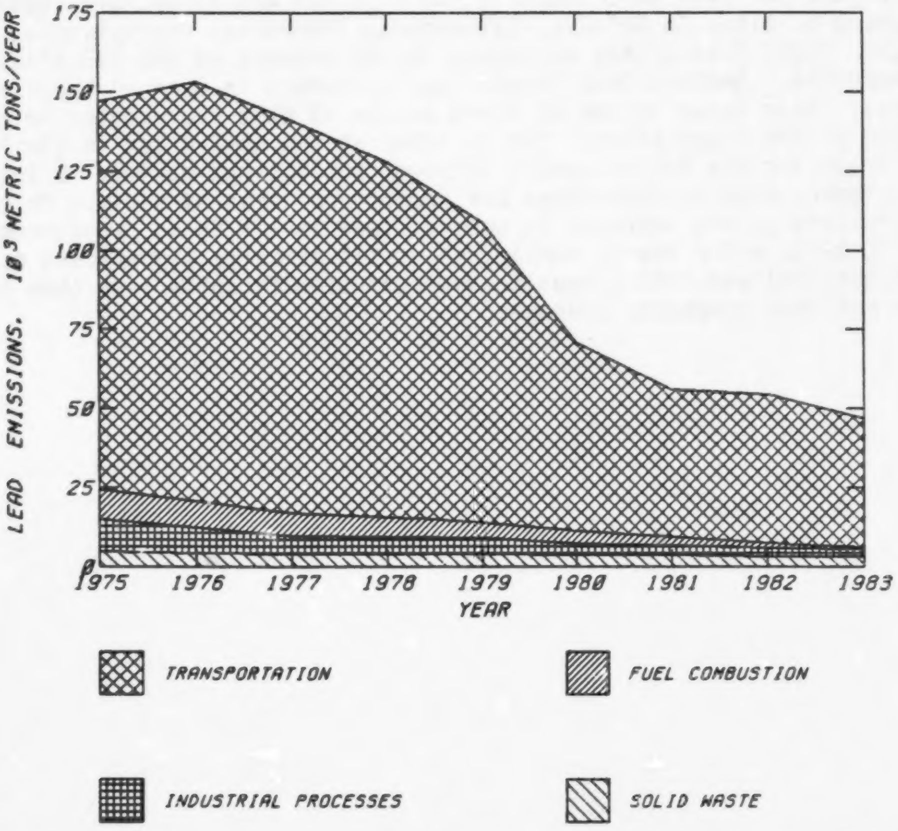


FIGURE 3-30. NATIONAL TREND IN LEAD EMISSIONS, 1975-1983.

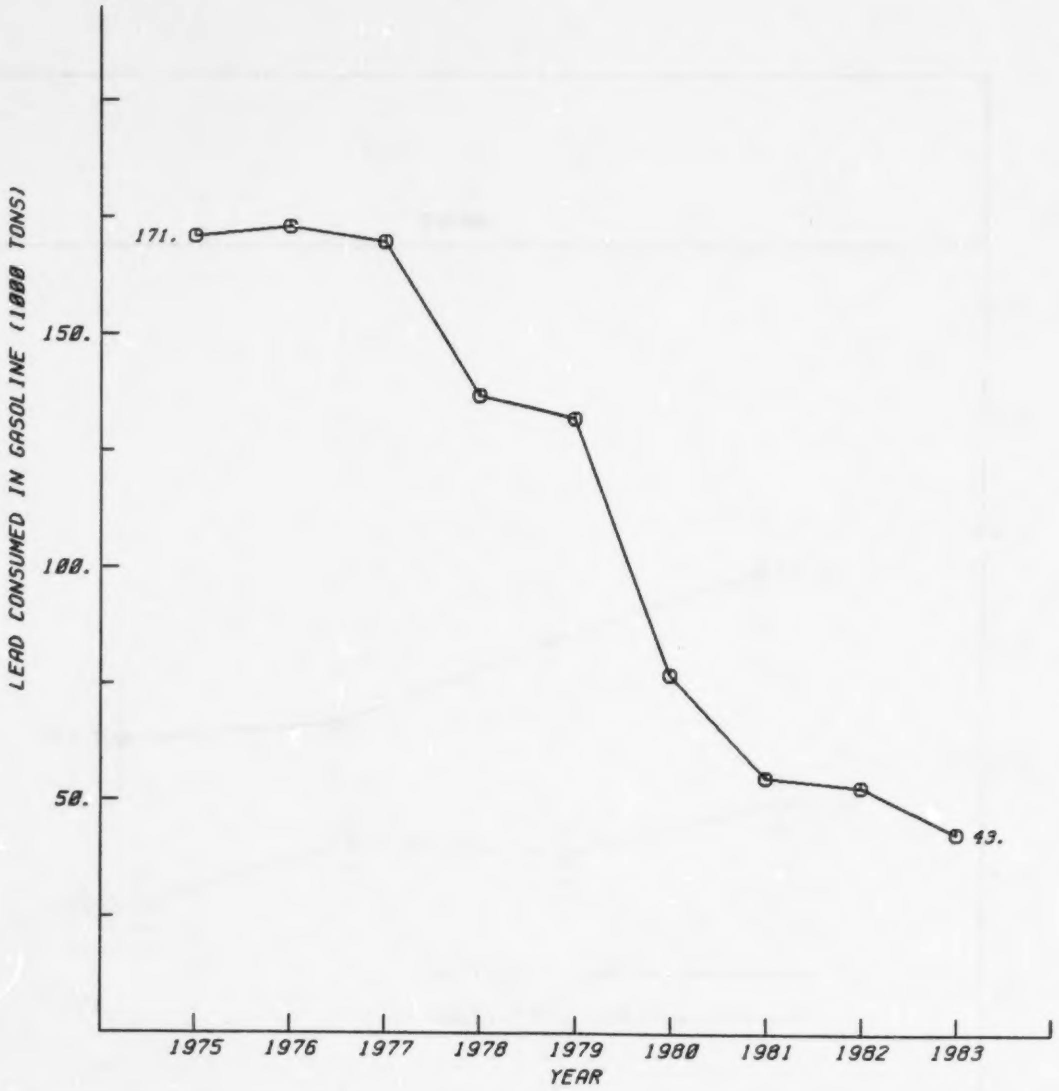


FIGURE 3-31. LEAD CONSUMED IN GASOLINE, 1975 - 1983.

(SALES TO THE MILITARY EXCLUDED)

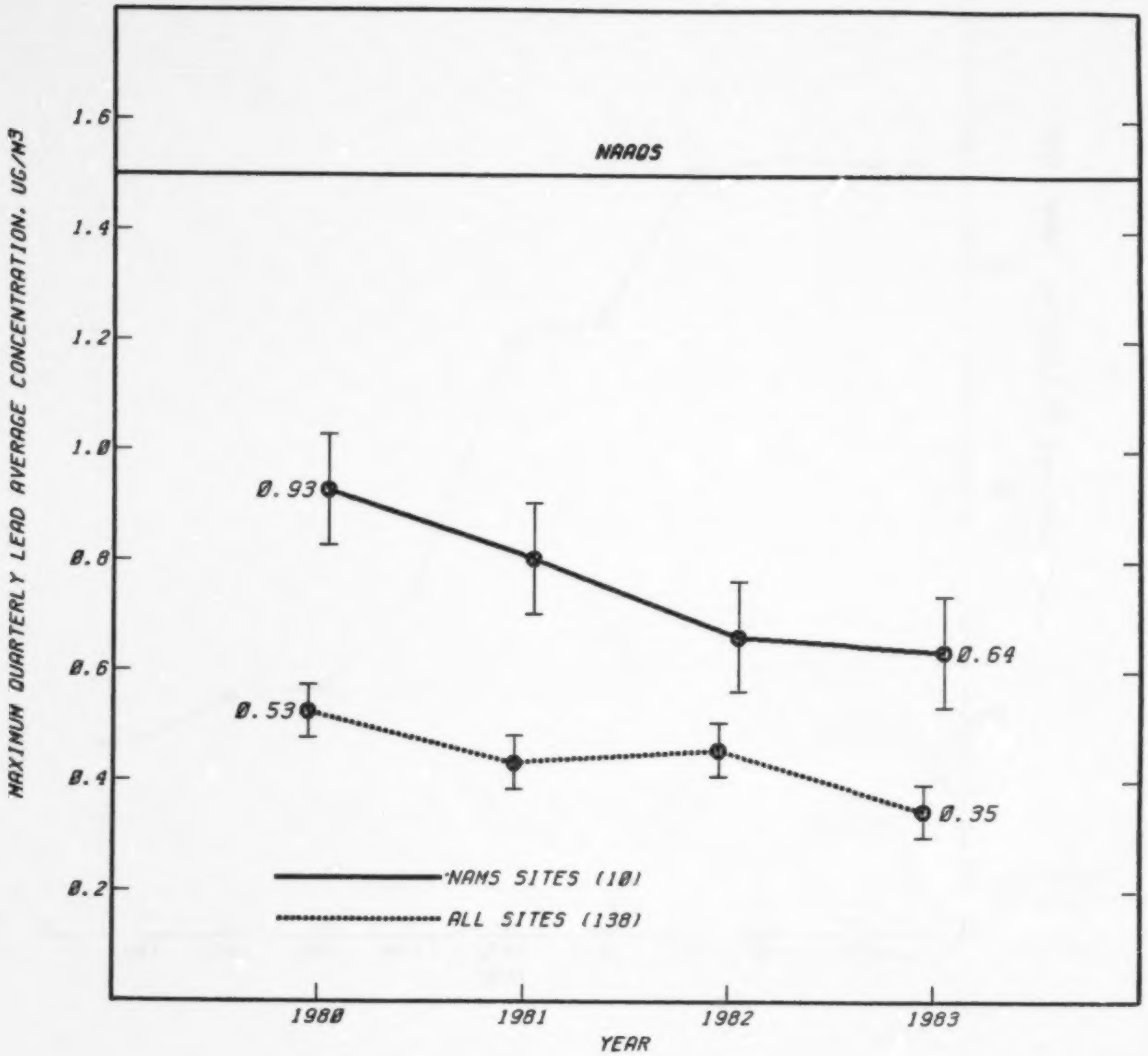


FIGURE 3-32. NATIONAL TREND IN MAXIMUM QUARTERLY AVERAGE LEAD LEVELS AT BOTH NAMS AND ALL SITES, 1980 - 1983.

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4. AIR QUALITY LEVELS IN STANDARD METROPOLITAN STATISTICAL AREAS

The Tables in this section summarize air quality by Standard Metropolitan Statistical Area (SMSA) for SMSA's with populations greater than 500,000. The air quality statistics relate to pollutant-specific NAAQS. The purpose of these summaries is to provide the reader with information on how air quality varies among SMSA's and from year-to-year. The higher air quality levels measured in the SMSA are summarized for the years 1981, 1982 and 1983.

The reader should be cautioned that these summaries are not sufficient in themselves to adequately rank or compare the SMSA's according to their air quality. To properly rank the air pollution severity in different SMSA(s), data on population characteristics, daily population mobility, transportation patterns, industrial composition, emission inventories, meteorological factors and, most important, the spatial representativeness of the monitoring sites would also be needed.

The same annual data completeness criterion used in the air quality trends data base was used here for the calculation of annual means. (See Section 2.1). If some data have been collected at one or more sites, but none of these sites meet the annual data completeness criteria, then the reader will be advised that there are insufficient data to calculate the annual mean.

With respect to the summary statistics for air quality levels with averaging times less than or equal to 24-hours, measured with continuous monitoring instruments, a footnote will be placed next to the level if the volume of annual data is less than 4380 hours for CO, less than 183 days for SO_2 or less than 50 percent of the days during the ozone season for ozone, which varies by state.[1] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October.

4.1 SUMMARY STATISTICS

In the following SMSA summaries, the air quality levels reported are the highest levels measured within the SMSA(s). The pollutant-specific statistics reported are summarized in Table 4-1, along with their associated primary NAAQS concentrations. For example, if an SMSA has three ozone monitors in 1981 with second highest daily hourly maxima of .15 ppm, .14 ppm and .12 ppm, the highest of these, .15 ppm, would be reported for that SMSA for 1981.

In the case of Pb, the quarterly average is based either on as many as 90 24-hour measurements or one or more chemical composite measurements.* Most of the maximum quarterly Pb averages are based on multiple 24-hour measurements. If the maximum quarterly average is based on a chemical composite, it is footnoted accordingly.

*A chemical composite measurement can be either a measurement for an entire month or an entire quarter.

Table 4-1. Air Quality Summary Statistics and Their Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	STATISTICS	PRIMARY NAAQS CONCENTRATION
Total Suspended Particulate	annual geometric mean	75 ug/m^3
Sulfur Dioxide	annual arithmetic mean	0.03 ppm
	second highest 24-hour average	0.14 ppm
Carbon Monoxide	second highest nonoverlapping 8-hour average	9 ppm
Nitrogen Dioxide	annual arithmetic mean	0.053 ppm
Ozone	second highest daily maximum 1-hour average	0.12 ppm
Lead	maximum quarterly average	1.5 ug/m^3

ug/m^3 = micrograms per cubic meter

ppm = parts per million

4.2 AIR QUALITY SMSA COMPARISONS

In each of the following SMSA air quality summaries, the SMSA's are grouped according to population starting with the largest SMSA - New York, NY-NJ and continuing to the smallest SMSA with a population in excess of 500,000, Long Branch - Asbury Park, NJ. The population groupings and the number of SMSA's contained within each are as follows: 16 SMSA's have populations in excess of 2 million, 23 SMSA's have populations between 1 and 2 million and 41 SMSA's have populations between 0.5 and 1 million. The population statistics are based on the 1980 census.

This year, air quality maps of the United States have been introduced to show at a glance how air quality vaires among the 80 SMSA's. Figures 4-1 through 4-7 appear just before the appropriate table summarizing the same air pollution specific statistic. The air quality summary statistics are summarized in the following figures and tables:

Figure 4-1. United States Map of the Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA, 1983.

Table 4-2. Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA, 1981-83.

Figure 4-2. United States Map of the Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1983.

Table 4-3. Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1981-83.

Figure 4-3. United States Map of the Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by SMSA, 1983.

Table 4-4. Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by SMSA, 1981-83.

Figure 4-4. United States Map of the Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by SMSA, 1983.

Table 4-5. Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by SMSA, 1981-83.

Figure 4-5. United States Map of the Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1983.

Table 4-6. Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1981-83.

Figure 4-6. United States Map of the Highest Second Daily Maximum 1-hour Average Ozone Concentrations by SMSA, 1983.

Table 4-7. Highest Second Daily Maximum 1-hour Average Ozone Concentration by SMSA, 1981-83.

Figure 4-7. United States Map of the Highest Maximum Quarterly Average Lead Concentration by SMSA, 1983.

Table 4-8. Highest Maximum Quarterly Average Lead Concentration by SMSA, 1981-83.

The air quality summaries follow:

4.3 REFERENCES

1. Rhoads, Richard G., U. S. Environmental Protection Agency, memorandum to Director of the Environmental Services Divisions and Air and Waste Management Divisions, EPA Regions I through X, 15 December 1982.

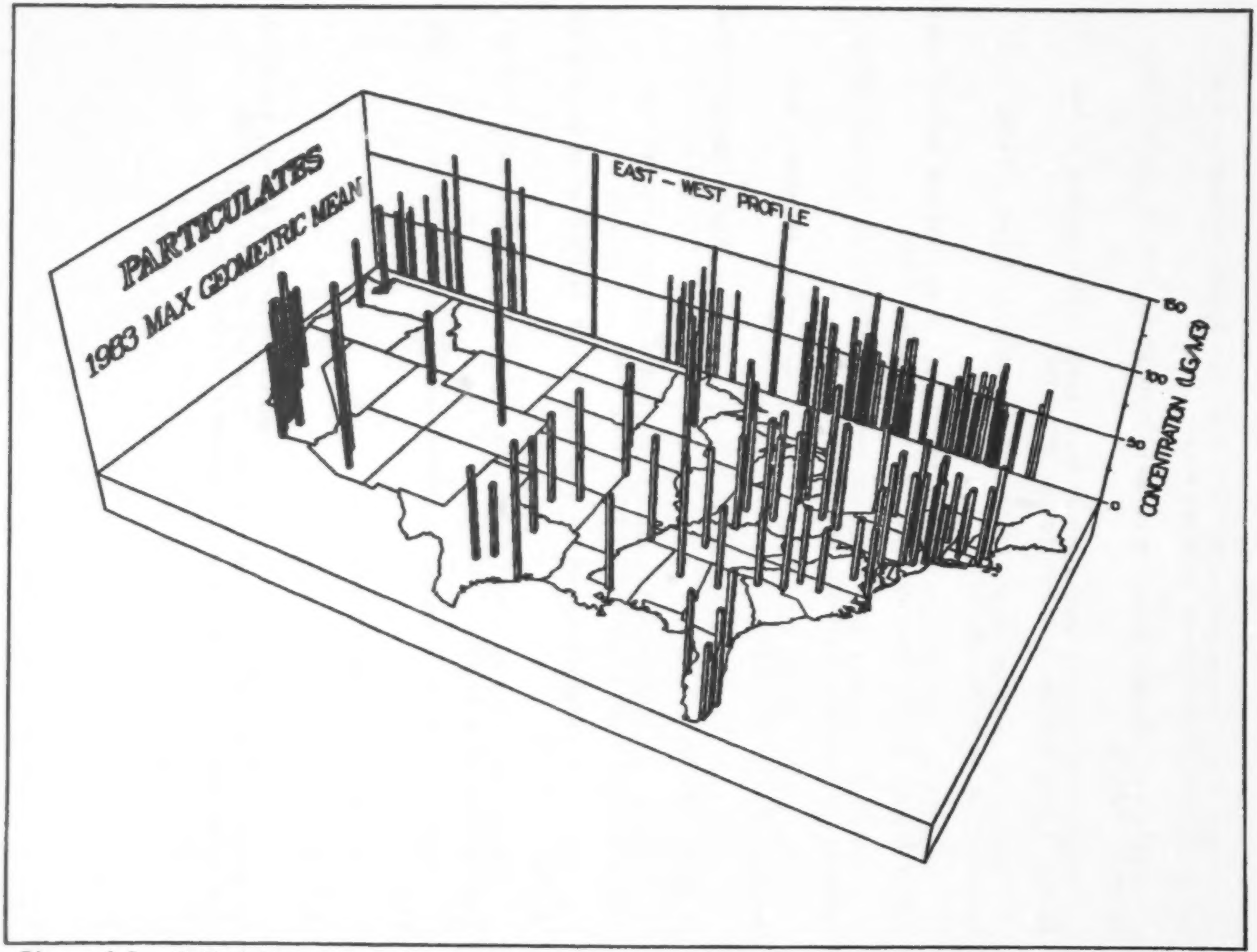

Figure 4-1. United States Map of the Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA, 1983.

Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	68	59	59
LOS ANGELES-LONG BEACH, CA	121	84	93
CHICAGO, IL	111	86	93
PHILADELPHIA, PA-NJ	82	68	68
DETROIT, MI	116	112	101
SAN FRANCISCO-OAKLAND, CA	56	53	55
WASHINGTON, DC-MD-VA	65	53	59
DALLAS-FORT WORTH, TX	77	81	70
HOUSTON, TX	151	138	101
BOSTON, MA	62	71	69
NASSAU-SUFFOLK, NY	56	54	44
ST. LOUIS, MO-IL	190	134	134
PITTSBURGH, PA	100	65	77

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	90	72	75
MINNEAPOLIS-ST. PAUL, MN-WI	100	73	72
ATLANTA, GA	79	63	60

TOTAL SMSA'S > 2 MILLION : 16

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	95	72	73
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	104	86	86
CLEVELAND, OH	129	101	96
SAN DIEGO, CA	95	76	55
MIAMI, FL	97	48	54
DENVER-BOULDER, CO	183	169	147
SEATTLE-EVERETT, WA	87	74	72
TAMPA-ST. PETERSBURG, FL	82	57	59
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	157	102	116
PHOENIX, AZ	178	140	125
CINCINNATI, OH-KY-IN	84	78	80
MILWAUKEE, WI	73	64	65
KANSAS CITY, MO-KS	96	71	70

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	64	53	56
BUFFALO, NY	97	82	66
PORTLAND, OR-WA	114	88	54
NEW ORLEANS, LA	82	63	70
INDIANAPOLIS, IN	80	67	70
COLUMBUS, OH	74	68	68
SAN JUAN, PR	94	81	73
SAN ANTONIO, TX	73	100	69
FORT LAUDERDALE-HOLLYWOOD, FL	69	48	41
SACRAMENTO, CA	68	55	62

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	73	88	49
SALT LAKE CITY-OGDEN, UT	67	68	57
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	57	56	57
MEMPHIS, TN-AR-MS	74	67	78
LOUISVILLE, KY-IN	92	75	70
NASHVILLE-DAVIDSON, TN	74	59	73
BIRMINGHAM, AL	111	84	88
OKLAHOMA CITY, OK	96	86	67
DAYTON, OH	77	60	63
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	61	54	56
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	64	53	51
ALBANY-SCHENECTADY-TROY, NY	59	55	51
TOLEDO, OH-MI	72	69	70

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN		
	1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	51	46	50
JACKSONVILLE, FL	79	74	56
HARTFORD, CT	47	48	47
ORLANDO, FL	67	50	47
TULSA, OK	99	88	83
AKRON, OH	67	67	60
GARY-HAMMOND-EAST CHICAGO, IN	121	90	83
SYRACUSE, NY	76	68	64
NORTHEAST PENNSYLVANIA	61	50	47
CHARLOTTE-GASTONIA, NC	67	62	54
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	84	68	57
RICHMOND, VA	50	45	46
GRAND RAPIDS, MI	58	49	52

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	69	60	58
WEST PALM BEACH-BOCA RATON, FL	59	45	43
OMAHA, NE-IA	91	64	65
GREENVILLE-SPARTANBURG, SC	63	52	53
JERSEY CITY, NJ	86	75	78
AUSTIN, TX	78	64	54
YOUNGSTOWN-WARREN, OH	96	84	75
TUCSON, AZ	112	93	105
RALEIGH-DURHAM, NC	53	45	46
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	73	51	48
OXNARD-SIMI VALLEY-VENTURA, CA	90	64	53
WILMINGTON, DE-NJ-MD	65	53	68
FLINT, MI	60	51	57

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
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Table 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1981	 1982	 1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	109	96	75
LONG BRANCH-ASBURY PARK, NJ	62	45	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
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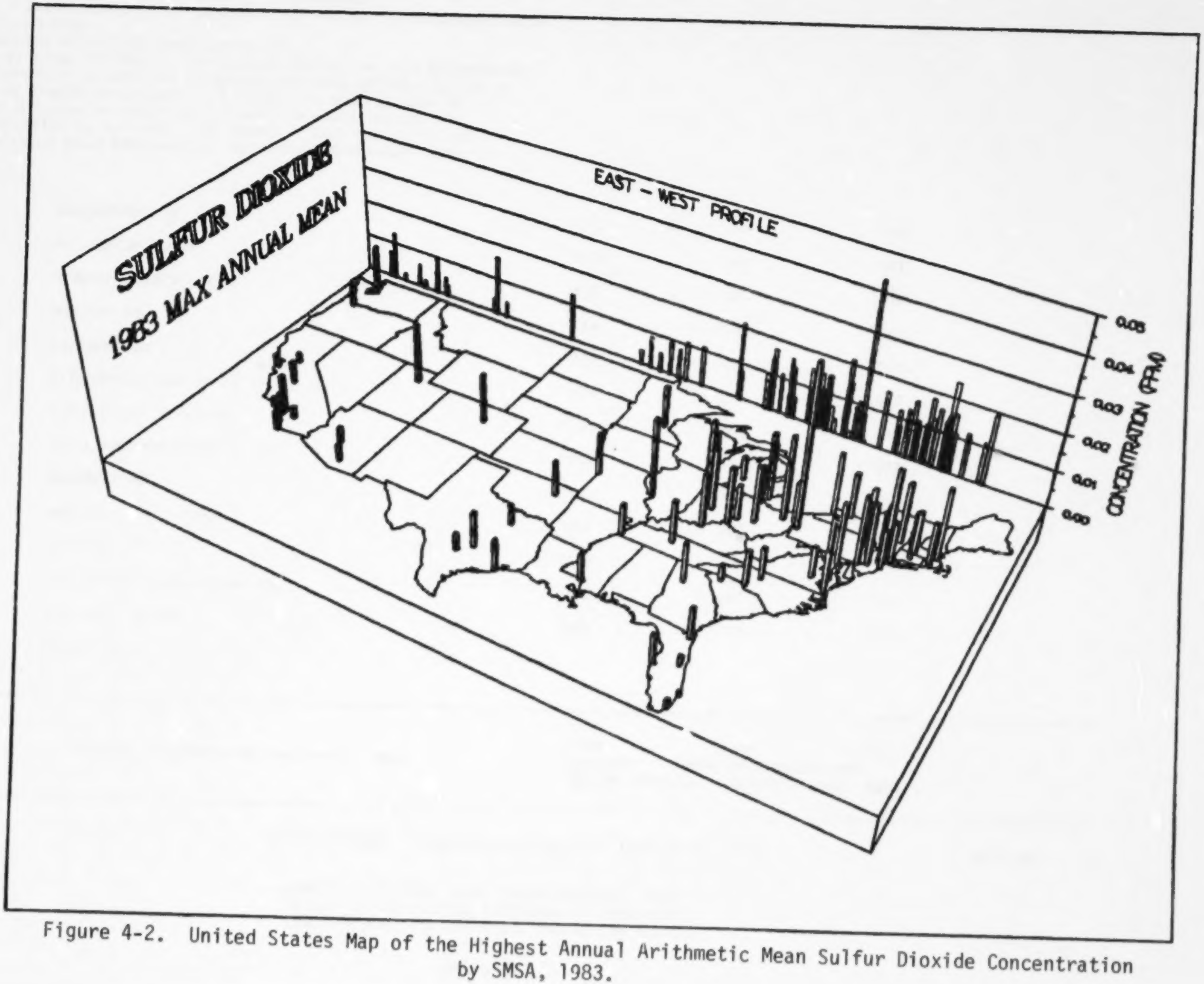

Figure 4-2. United States Map of the Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1983.

Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.025	.025	.024
LOS ANGELES-LONG BEACH, CA	.011	.003	.010
CHICAGO, IL	.015	.012	.014
PHILADELPHIA, PA-NJ	.022	.020	.016
DETROIT, MI	.017	.018	.015
SAN FRANCISCO-OAKLAND, CA	.005	.009	.003
WASHINGTON, DC-MD-VA	.017	.018	.013
DALLAS-FORT WORTH, TX	.003	.003	.005
HOUSTON, TX	.005	.009	.008
BOSTON, MA	.019	.018	.019
NASSAU-SUFFOLK, NY	.011	.012	.011
ST. LOUIS, MO-IL	.022	.020	.021
PITTSBURGH, PA	.045	.046	.043

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.015	.020	.016
MINNEAPOLIS-ST. PAUL, MN-WI	.015	.018	.011
ATLANTA, GA	.009	IN	.010
TOTAL SMSA'S > 2 MILLION : 16			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.021	.017	.014
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.007	IN	.006
CLEVELAND, OH	.019	.023	.021
SAN DIEGO, CA	.007	.007	.005
MIAMI, FL	.003	.003	.002
DENVER-BOULDER, CO	.013	.011	.013
SEATTLE-EVERETT, WA	.015	.015	.013
TAMPA-ST. PETERSBURG, FL	.010	.009	.007
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.007	.006	.003
PHOENIX, AZ	.006	IN	.004
CINCINNATI, OH-KY-IN	.014	.015	.015
MILWAUKEE, WI	.009	.010	.010
KANSAS CITY, MO-KS	.019	.014	.011

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	ND	ND	ND
BUFFALO, NY	.026	.017	.016
PORTLAND, OR-WA	.012	.009	.007
NEW ORLEANS, LA	IN	.004	.007
INDIANAPOLIS, IN	.027	.018	.016
COLUMBUS, OH	.015	.017	.015
SAN JUAN, PR	IN	.008	ND
SAN ANTONIO, TX	.002	.003	.004
FORT LAUDERDALE-HOLLYWOOD, FL	.002 B	.001 B	IN
SACRAMENTO, CA	.004	.002	.002

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.022	.014	.012
SALT LAKE CITY-OGDEN, UT	.035	.026	.016
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.015	.016	.011
MEMPHIS, TN-AR-MS	.018	.011	.008
LOUISVILLE, KY-IN	.019	.017	.014
NASHVILLE-DAVIDSON, TN	.011	.013	.011
BIRMINGHAM, AL	.007	IN	IN
OKLAHOMA CITY, OK	.003	.001	IN
DAYTON, OH	.008 B	.008	.009
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.004 B	.005 B	.008
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.013	.011	.011
ALBANY-SCHENECTADY-TROY, NY	.013	.018	.016
TOLEDO, OH-MI	.014	.012	.010

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.007 B	.004 B	.003
JACKSONVILLE, FL	.020 B	.007	.008
HARTFORD, CT	.011	.014	.012
ORLANDO, FL	.006	.006	.002
TULSA, OK	.008	.008	.009
AKRON, OH	.021	.019	.015
GARY-HAMMOND-EAST CHICAGO, IN	.013	.014	.017
SYRACUSE, NY	.010	.010	.010
NORTHEAST PENNSYLVANIA	.012	.013	.011
CHARLOTTE-GASTONIA, NC	.011	.011	.009
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.016	.014	.013
RICHMOND, VA	IN	.008	.008
GRAND RAPIDS, MI	.008	.008	.006

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.018	.014	.013
WEST PALM BEACH-BOCA RATON, FL	.003	.003	.001
OMAHA, NE-IA	.004 B	.004	IN
GREENVILLE-SPARTANBURG, SC	.003	.006	.004
JERSEY CITY, NJ	.018	.015	.015
AUSTIN, TX	.001	.006	.009
YOUNGSTOWN-WARREN, OH	.015 B	.016	.011
TUCSON, AZ	.016	.009	.004
RALEIGH-DURHAM, NC	.003 B	.002 B	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.011	.012	.011
OXNARD-SIMI VALLEY-VENTURA, CA	ND	.003	.002
WILMINGTON, DE-NJ-MD	.010	.010	.018
FLINT, MI	.014	.016	.015

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.003	.004	.006
LONG BRANCH-ASBURY PARK, NJ	.008	.007	.010
TOTAL SMSA'S .5 - 1 MILLION : 41			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

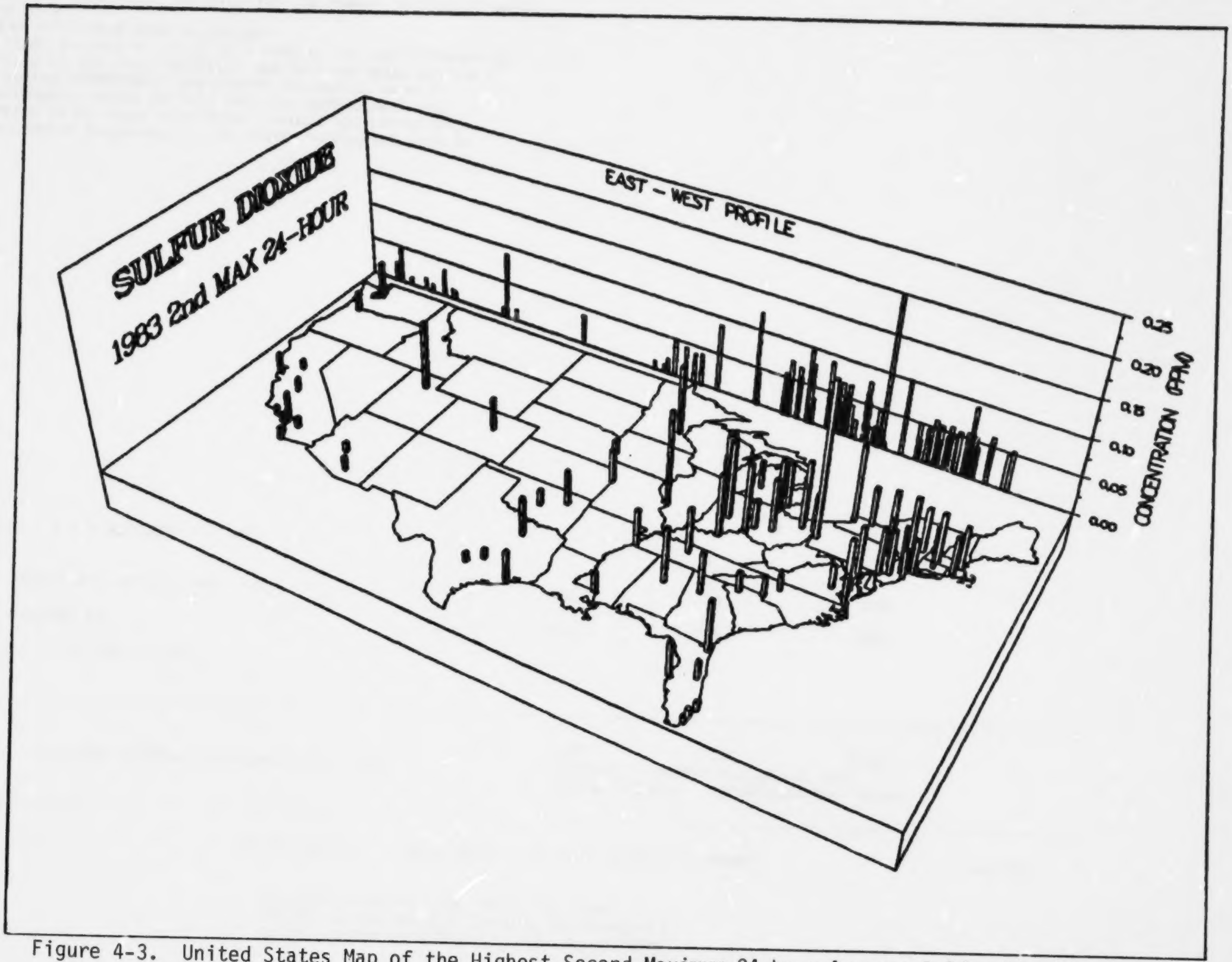

SULFUR DIOXIDE
1983 2nd MAX 24-HOUR
EAST - WEST PROFILE
0.25
0.20
0.15
0.10
0.05
0.00
CONCENTRATION (PPM)

Figure 4-3. United States Map of the Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by SMSA, 1983.

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.097	.079	.093
LOS ANGELES-LONG BEACH, CA	.036	.027 *	.037
CHICAGO, IL	.061	.056	.048
PHILADELPHIA, PA-NJ	.081	.065	.056
DETROIT, MI	.102	.069	.057
SAN FRANCISCO-OAKLAND, CA	.018	.020	.025
WASHINGTON, DC-MD-VA	.047	.060	.046
DALLAS-FORT WORTH, TX	.029	.017	.048
HOUSTON, TX	.047 *	.071	.040 *
BOSTON, MA	.066	.061	.054
NASSAU-SUFFOLK, NY	.054	.056	.044
ST. LOUIS, MO-IL	.114	.479 **	.123
PITTSBURGH, PA	.192	.212	.197

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT
** THIS VALUE HAS BEEN REVIEWED AND VERIFIED BY EPA'S REGIONAL OFFICE.
IT RESULTS FROM SO2 EMISSIONS FROM 2 POWER PLANTS NEAR THE MONITORING SITE.

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.058 *	.071 *	.060
MINNEAPOLIS-ST. PAUL, MN-WI	.160	.225	.089
ATLANTA, GA	.034	.038 *	.052

TOTAL SMSA'S > 2 MILLION : 16

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE HIGHEST 1981	CONCENTRATION (PPM) 2ND MAX 24-HR AVG. 1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.114	.067	.052
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.019	.015 *	.015
CLEVELAND, OH	.081 *	.071	.080
SAN DIEGO, CA	.023	.030	.014
MIAMI, FL	.010	.009	.008
DENVER-BOULDER, CO	.043	.039	.041
SEATTLE-EVERETT, WA	.066	.051	.047
TAMPA-ST. PETERSBURG, FL	.042	.047	.043
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.030	.016	.012
PHOENIX, AZ	.037	.011 *	.012
CINCINNATI, OH-KY-IN	.106	.096	.090
MILWAUKEE, WI	.066	.049	.056
KANSAS CITY, MO-KS	.208	.128	.042

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE. CA	ND	ND	ND
BUFFALO, NY	.277	.077	.100
PORTLAND, OR-WA	.051	.033	.025
NEW ORLEANS, LA	.024 *	.020	.025
INDIANAPOLIS, IN	.073 *	.068	.099
COLUMBUS, OH	.064	.066	.068
SAN JUAN, PR	.038 *	.040	ND
SAN ANTONIO, TX	.008	.011	.011
FORT LAUDERDALE-HOLLYWOOD, FL	.009 B	.004 B	.011 B
SACRAMENTO, CA	.011	.008	.010

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.090	.055	.050
SALT LAKE CITY-OGDEN, UT	.160	.085	.089
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.065	.060	.047
MEMPHIS, TN-AR-MS	.157	.055	.045
LOUISVILLE, KY-IN	.130	.077	.079
NASHVILLE-DAVIDSON, TN	.072	.077	.056
BIRMINGHAM, AL	.024	.029 *	.069 *
OKLAHOMA CITY, OK	.009	.012 *	.020 *
DAYTON, OH	.054 B	.039	.036
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.015 B	.016 B	.018
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.047	.034	.036
ALBANY-SCHENECTADY-TROY, NY	.066 *	.068	.056
TOLEDO, OH-MI	.061	.082	.068

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.113 B	.045 B	.023 *
JACKSONVILLE, FL	.122	.056 *	.064
HARTFORD, CT	.074	.053	.054
ORLANDO, FL	.025	.034	.021
TULSA, OK	.071	.053	.044
AKRON, OH	.117	.114	.054
GARY-HAMMOND-EAST CHICAGO, IN	.055	.049	.074
SYRACUSE, NY	.034	.038	.056
NORTHEAST PENNSYLVANIA	.066	.055	.045
CHARLOTTE-GASTONIA, NC	.042	.043	.025
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.074	.052	.046
RICHMOND, VA	.049 *	.036	.029
GRAND RAPIDS, MI	.030	.025	.034

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	 1982	 1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.085	.058	.058
WEST PALM BEACH-BOCA RATON, FL	.018	.016	.009
OMAHA, NE-IA	.016 B	.033	.018 *
GREENVILLE-SPARTANBURG, SC	.016	.026 *	.025
JERSEY CITY, NJ	.078	.050	.048
AUSTIN, TX	.006	.012	.011
YOUNGSTOWN-WARREN, OH	.058	.062	.048
TUCSON, AZ	.106	.049	.016
RALEIGH-DURHAM, NC	.009 B	.004 B	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.055	.066	.063
OXNARD-SIMI VALLEY-VENTURA, CA	ND	.011	.010
WILMINGTON, DE-NJ-MD	.058	.042	.058
FLINT, MI	.036	.045	.041

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-4

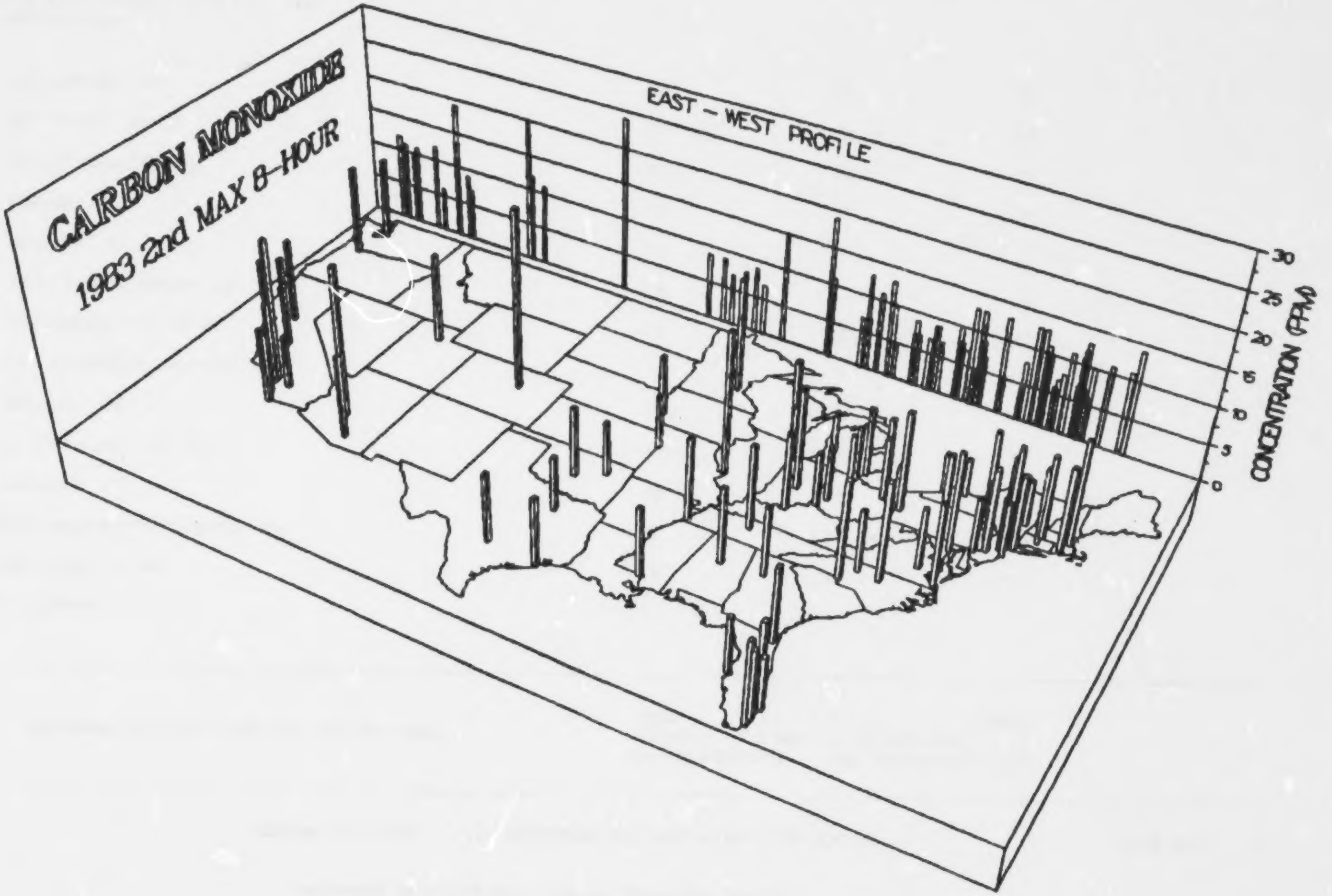
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.012	.016	.016
LONG BRANCH-ASBURY PARK, NJ	.050	.041	.036

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT



CARBON MONOXIDE
1983 2nd MAX 8-HOUR
EAST - WEST PROFILE
CONCENTRATION (PPM)
30
25
20
15
10
5
0

Figure 4-4. United States Map of the Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by SMSA, 1983.

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG.		
	1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	15	13	13
LOS ANGELES-LONG BEACH, CA	21	19 *	19
CHICAGO, IL	10	14	13
PHILADELPHIA, PA-NJ	10	12	11
DETROIT, MI	12	10	9
SAN FRANCISCO-OAKLAND, CA	7	9	9
WASHINGTON, DC-MD-VA	13	12	13
DALLAS-FORT WORTH, TX	7	7	7
HOUSTON, TX	7	10	9 *
BOSTON, MA	10	21	14
NASSAU-SUFFOLK, NY	11	10	10
ST. LOUIS, MO-IL	11	9 *	19
PITTSBURGH, PA	11	11	13

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	13	12	13
MINNEAPOLIS-ST. PAUL, MN-WI	13 *	14	15
ATLANTA, GA	10	8	9
TOTAL SMSA'S > 2 MILLION : 16			

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	 1982	 1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	13	13	11
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	12	11 *	11
CLEVELAND, OH	10	9	10
SAN DIEGO, CA	9	9	9
MIAMI, FL	15	11	11
DENVER-BOULDER, CO	28	17	24
SEATTLE-EVERETT, WA	14	12	11
TAMPA-ST. PETERSBURG, FL	8	7	7
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	9	7	7
PHOENIX, AZ	19	18	20
CINCINNATI, OH-KY-IN	10	8	7
MILWAUKEE, WI	9	9	7
KANSAS CITY, MO-KS	15	12	7

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	11	11	10
BUFFALO, NY	6	5	5
PORTLAND, OR-WA	12	10	12
NEW ORLEANS, LA	7	10	9
INDIANAPOLIS, IN	15	11	13
COLUMBUS, OH	10	9	9
SAN JUAN, PR	13 *	18	8
SAN ANTONIO, TX	8 *	8	9
FORT LAUDERDALE-HOLLYWOOD, FL	10	9	9
SACRAMENTO, CA	12	10	11

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	9	6	5
SALT LAKE CITY-OGDEN, UT	11 *	12	12 *
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	10	9	11
MEMPHIS, TN-AR-MS	14	13 *	11
LOUISVILLE, KY-IN	13	13	10
NASHVILLE-DAVIDSON, TN	12	12	11
BIRMINGHAM, AL	8 *	9	10
OKLAHOMA CITY, OK	8	8	9
DAYTON, OH	8	7	7
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	7	8	8
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	6	6	11
ALBANY-SCHENECTADY-TROY, NY	7	8	6
TOLEDO, OH-MI	7	7	7

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	6	7	6
JACKSONVILLE, FL	9	9	10
HARTFORD, CT	8	9	10
ORLANDO, FL	8 *	9	7
TULSA, OK	10 *	6	7
AKRON, OH	9 *	6	8
GARY-HAMMOND-EAST CHICAGO, IN	10	6 *	7
SYRACUSE, NY	4	5	10 *
NORTHEAST PENNSYLVANIA	ND	6 *	6
CHARLOTTE-GASTONIA, NC	12	11	13
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	5 *	8 *	8
RICHMOND, VA	9	8	8 *
GRAND RAPIDS, MI	6	5	5

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	7	8	7
WEST PALM BEACH-BOCA RATON, FL	5	7	7
OMAHA, NE-IA	9	16	8
GREENVILLE-SPARTANBURG, SC	ND	ND	ND
JERSEY CITY, NJ	10	13	12
AUSTIN, TX	ND	ND	ND
YOUNGSTOWN-WARREN, OH	7	5	5
TUCSON, AZ	10	11	11
RALEIGH-DURHAM, NC	12	14 *	13
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	7 *	9	11
OXNARD-SIMI VALLEY-VENTURA, CA	ND	7	6
WILMINGTON, DE-NJ-MD	11	7	7
FLINT, MI	1 *	ND	ND

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

Table 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	12	13	12
LONG BRANCH-ASBURY PARK, NJ	10	8	7

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

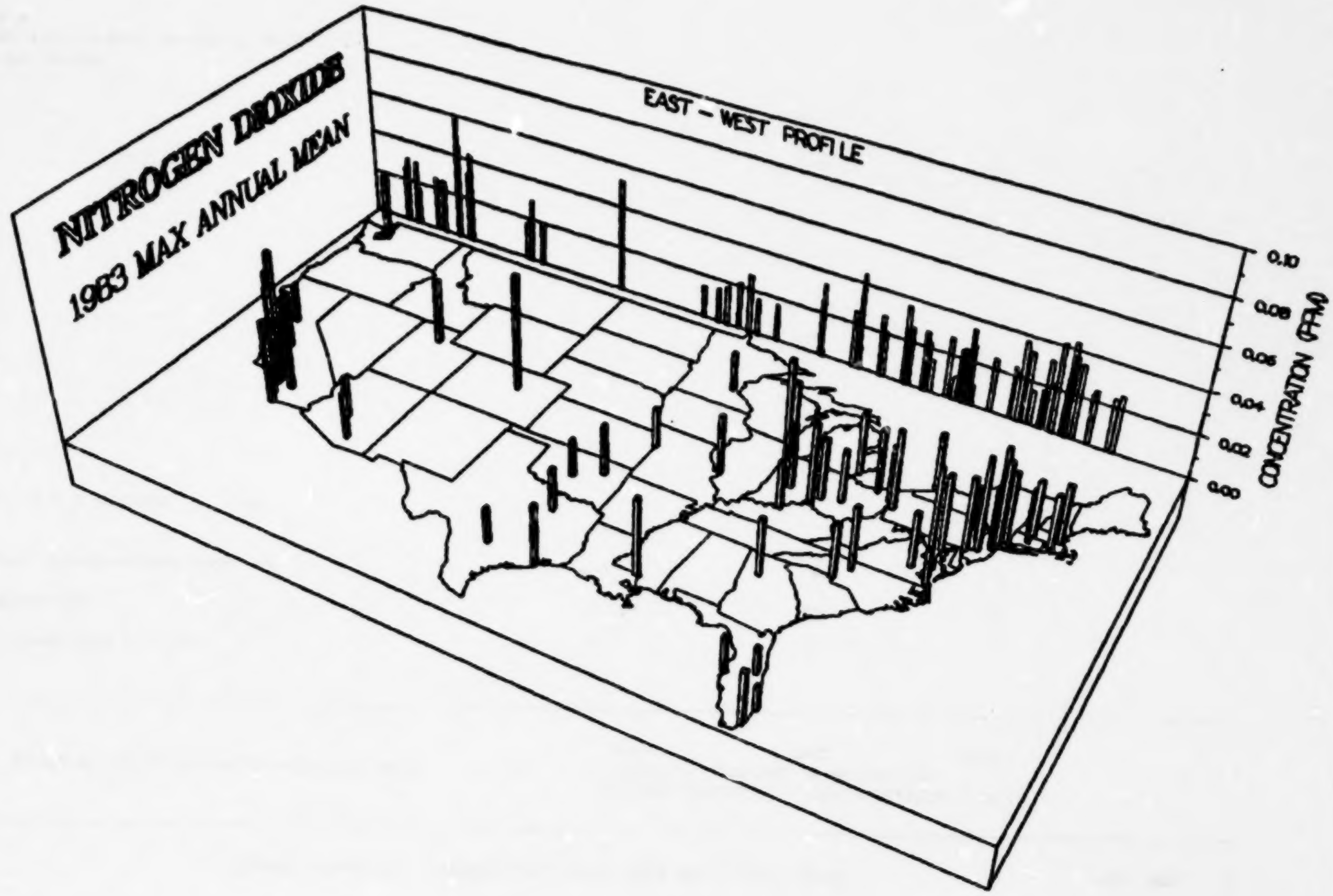


Figure 4-5. United States Map of the Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1983.

Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.034	.036	.037
LOS ANGELES-LONG BEACH, CA	.071	.062	.059
CHICAGO, IL	.052 B	.052 B	.044 B
PHILADELPHIA, PA-NJ	.046	.039	.041
DETROIT, MI	.038	.019	.027
SAN FRANCISCO-OAKLAND, CA	.027	.027	.026
WASHINGTON, DC-MD-VA	.034	.036	.037 B
DALLAS-FORT WORTH, TX	.017	.019	.018
HOUSTON, TX	.025	.024	.027
BOSTON, MA	.041	.036	.026
NASSAU-SUFFOLK, NY	.028	.033	.034
ST. LOUIS, MO-IL	.026	.025	.026
PITTSBURGH, PA	.034	.031	.035

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.030	.032	.033
MINNEAPOLIS-ST. PAUL, MN-WI	.028 B	.023	.017
ATLANTA, GA	IN	.016	.025
TOTAL SMSA'S > 2 MILLION : 16			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.034	.045	.043
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.061	IN	.045
CLEVELAND, OH	.039 B	.037 B	.028
SAN DIEGO, CA	.043	.030	.033
MIAMI, FL	.018	.023	.023
DENVER-BOULDER, CO	.047	.041	.052
SEATTLE-EVERETT, WA	.022	.048	.031
TAMPA-ST. PETERSBURG, FL	.030 B	.022 B	.015
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.049	.044	.042
PHOENIX, AZ	.011	.031	.018
CINCINNATI, OH-KY-IN	.031	.034	.036
MILWAUKEE, WI	.026	.028	.026
KANSAS CITY, MO-KS	.014	.018	.017

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	.033	.032	.030
BUFFALO, NY	.026	.026	.025
PORTLAND, OR-WA	IN	ND	ND
NEW ORLEANS, LA	.030 B	.033 B	.034 B
INDIANAPOLIS, IN	.030	.028	.028
COLUMBUS, OH	.023	.020	.023
SAN JUAN, PR	ND	ND	ND
SAN ANTONIO, TX	.026 B	.013	.015
FORT LAUDERDALE-HOLLYWOOD, FL	.027 B	.022 B	IN
SACRAMENTO, CA	.021	.019	.017

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN		
	1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	ND	ND	ND
SALT LAKE CITY-OGDEN, UT	.028	.031	.029
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	IN	.025	.024
MEMPHIS, TN-AR-MS	.018	.022	.003
LOUISVILLE, KY-IN	.035	.034 B	.021
NASHVILLE-DAVIDSON, TN	.049 B	.053 B	ND
BIRMINGHAM, AL	ND	ND	ND
OKLAHOMA CITY, OK	.023	.018	.016
DAYTON, OH	.028 B	.027	.027
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.022 B	.023 B	.028 B
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.015	.015	.016
ALBANY-SCHENECTADY-TROY, NY	ND	ND	ND
TOLEDO, OH-MI	.031 B	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	IN	IN	.002
JACKSONVILLE, FL	.017	.008	IN
HARTFORD, CT	.019	.021	.023
ORLANDO, FL	.027	IN	.011
TULSA, OK	.010	.022	.022
AKRON, OH	.024 B	ND	ND
GARY-HAMMOND-EAST CHICAGO, IN	ND	.009	.010
SYRACUSE, NY	ND	ND	ND
NORTHEAST PENNSYLVANIA	.029	.022	.018
CHARLOTTE-GASTONIA, NC	.026 B	.026 B	.024 B
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.026	.023	.022
RICHMOND, VA	IN	.024	.024
GRAND RAPIDS, MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	IN	.027	.027
WEST PALM BEACH-BOCA RATON, FL	.015 B	IN	.010
OMAHA, NE-IA	.020 B	ND	ND
GREENVILLE-SPARTANBURG, SC	.029 B	.024 B	ND
JERSEY CITY, NJ	.028	.032	.032
AUSTIN, TX	ND	ND	ND
YOUNGSTOWN-WARREN, OH	.035	.029	.025
TUCSON, AZ	.037	.036	.020
RALEIGH-DURHAM, NC	.019 B	.018 B	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	IN	.021	.025
OXNARD-SIMI VALLEY-VENTURA, CA	IN	.028	.025
WILMINGTON, DE-NJ-MD	IN	.020	.032
FLINT, MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

Table 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.026	.022	.025
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

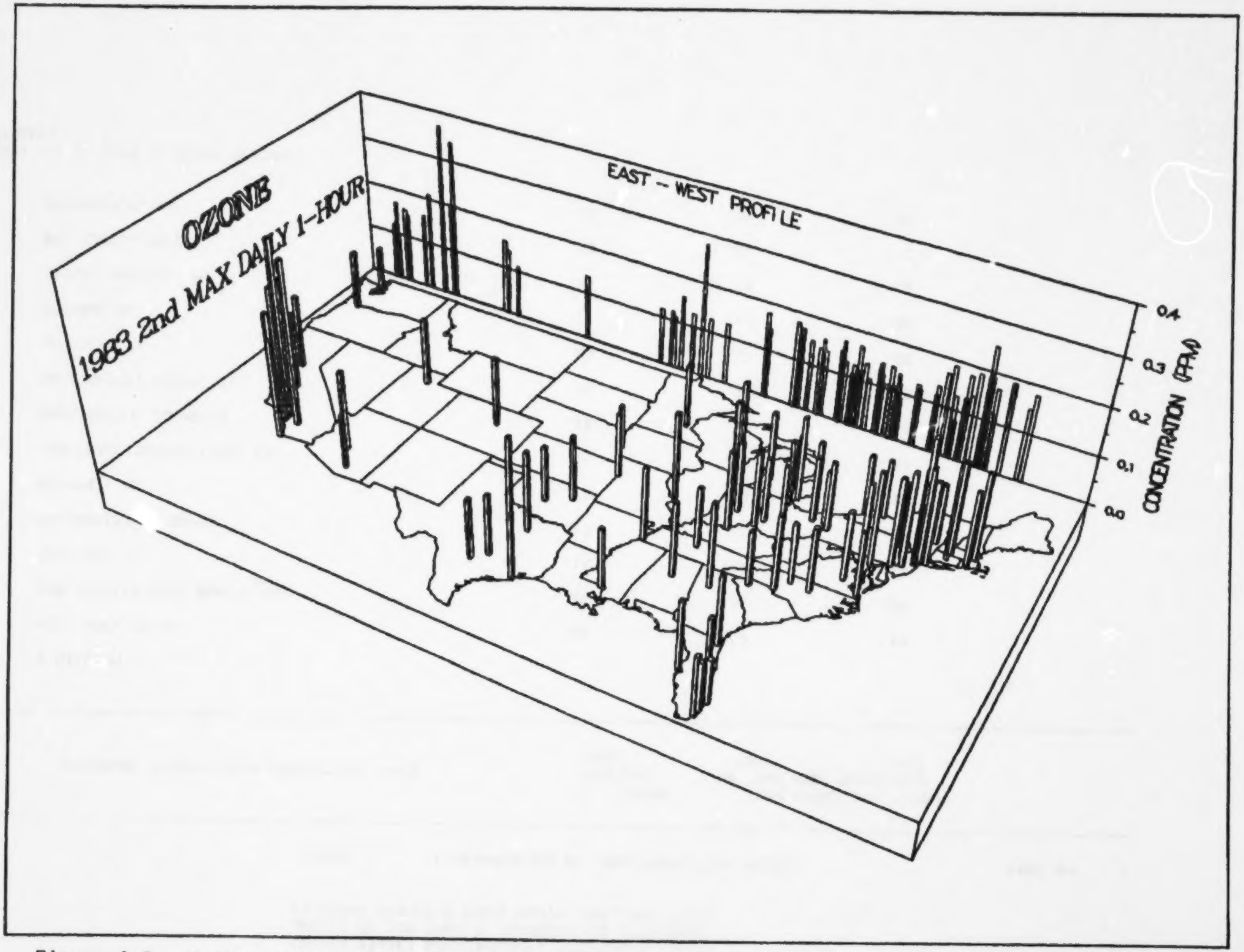


Figure 4-6. United States Map of the Highest Second Daily Maximum 1-hour Average Ozone Concentrations by SMSA, 1983.

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.18	.17	.19
LOS ANGELES-LONG BEACH, CA	.35	.32	.37
CHICAGO, IL	.14	.12	.17
PHILADELPHIA, PA-NJ	.17	.18	.19
DETROIT, MI	.15	.16	.14
SAN FRANCISCO-OAKLAND, CA	.14	.14	.17
WASHINGTON, DC-MD-VA	.15	.15	.17
DALLAS-FORT WORTH, TX	.15	.17	.16
HOUSTON, TX	.23	.21	.28
BOSTON, MA	.13	.16 *	.18
NASSAU-SUFFOLK, NY	.14	.13	.17
ST. LOUIS, MO-IL	.15	.16	.18
PITTSBURGH, PA	.16	.14	.14

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1981	1-HR CONCENTRATION 2ND HIGH 1982	(PPM) DAILY MAX 1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.17	.14	.19
MINNEAPOLIS-ST. PAUL, MN-WI	.10	.10	.13
ATLANTA, GA	.14	.14	.17

TOTAL SMSA'S > 2 MILLION : 16

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1981	1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.14	.17	.25
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.31	.18 *	.28
CLEVELAND, OH	.12	.13	.15
SAN DIEGO, CA	.24	.21	.20
MIAMI, FL	.14	.14	.12
DENVER-BOULDER, CO	.13	.14	.14
SEATTLE-EVERETT, WA	.12	.09	.10
TAMPA-ST. PETERSBURG, FL	.12	.12	.14
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.34	.32	.34
PHOENIX, AZ	.16	.12	.16
CINCINNATI, OH-KY-IN	.13	.13	.15
MILWAUKEE, WI	.17	.13	.18
KANSAS CITY, MO-KS	.12	.10	.13

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1981	1982	1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	.14	.14	.16
BUFFALO, NY	.12 *	.11	.12
PORTLAND, OR-WA	.15	.12	.12
NEW ORLEANS, LA	.12	.17	.12
INDIANAPOLIS, IN	.13	.12	.14
COLUMBUS, OH	.11	.13	.12
SAN JUAN, PR	.07	.04 *	ND
SAN ANTONIO, TX	.12	.14	.12
FORT LAUDERDALE-HOLLYWOOD, FL	.11	.09	.10
SACRAMENTO, CA	.17	.16	.15

TOTAL SMSA'S 1 - 2 MILLION : 23

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX		
	1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.12	.11	.12
SALT LAKE CITY-OGDEN, UT	.16	.14	.14
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.15	.15	.15
MEMPHIS, TN-AR-MS	.14	.13	.15
LOUISVILLE, KY-IN	.14	.17	.16
NASHVILLE-DAVIDSON, TN	.13	.11	.12
BIRMINGHAM, AL	.16	.15	.15
OKLAHOMA CITY, OK	.11	.11 *	.11
DAYTON, OH	.13	.16	.13
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.11	.11	.12
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.12	.11	.13
ALBANY-SCHENECTADY-TROY, NY	.12	.12	.12
TOLEDO, OH-MI	.13	.13	.13

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.05	.07	.06
JACKSONVILLE, FL	.11	.12	.14
HARTFORD, CT	.15	.17	.19
ORLANDO, FL	.10	.10 *	.11
TULSA, OK	.15	.13	.13
AKRON, OH	.24	.14	.13
GARY-HAMMOND-EAST CHICAGO, IN	.14	.13	.17
SYRACUSE, NY	.11	.12	.08
NORTHEAST PENNSYLVANIA	.10	.16	.13
CHARLOTTE-GASTONIA, NC	.12	.12	.15
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.12	.15	.14
RICHMOND, VA	.12	.12	.14
GRAND RAPIDS, MI	.11	.11	.14

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1-HR 2ND HIGH DAILY MAX CONCENTRATION (PPM) 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.13	.16	.19
WEST PALM BEACH-BOCA RATON, FL	.09	.09	.09
OMAHA, NE-IA	.08	.09	.09
GREENVILLE-SPARTANBURG, SC	.11	.11	.11
JERSEY CITY, NJ	.14	.14	.16
AUSTIN, TX	.12	.11	.12
YOUNGSTOWN-WARREN, OH	.13	.11	.11
TUCSON, AZ	.10	.12	.11
RALEIGH-DURHAM, NC	.12	.09	.13
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.16	.16	.19
OXNARD-SIMI VALLEY-VENTURA, CA	.20	.22	.21
WILMINGTON, DE-NJ-MD	.12 *	.16	.18
FLINT, MI	.11	.11	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

Table 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.17	.16	.16
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

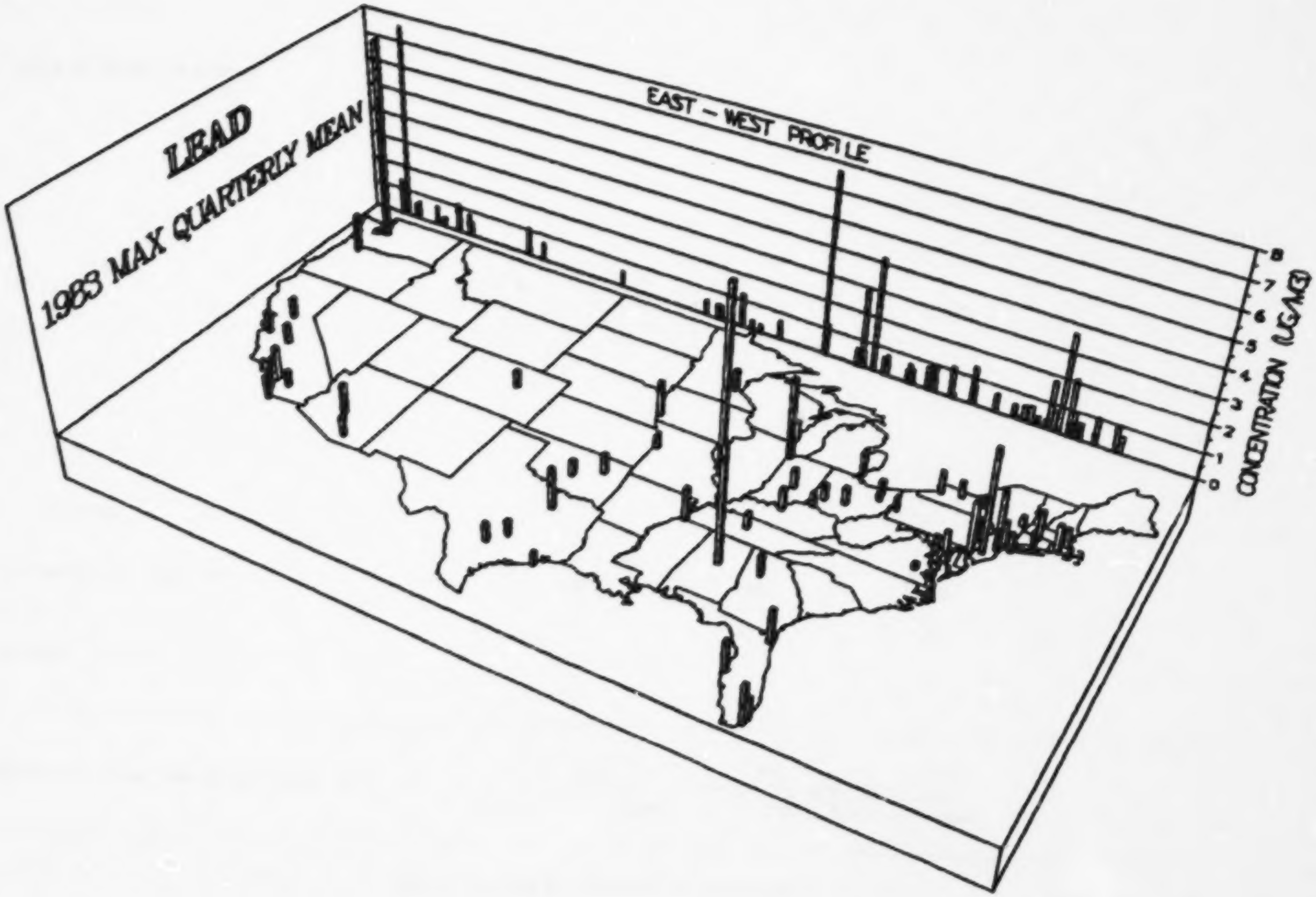

LEAD
1983 MAX QUARTERLY MEAN
EAST – WEST PROFILE
CONCENTRATION (UG/M3)
0
1
2
3
4
5
6
7
8

Figure 4-7. United States Map of the Highest Maximum Quarterly Average Lead Concentration by SMSA, 1983.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1981	1982	1983
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.37	.62	.90
LOS ANGELES-LONG BEACH, CA	1.58	1.68	1.10
CHICAGO, IL	.89	4.43 M	2.86 M
PHILADELPHIA, PA-NJ	1.30 *	1.57 *	3.66 *
DETROIT, MI	.34	ND	.82 Q
SAN FRANCISCO-OAKLAND, CA	.43	.55	.37
WASHINGTON, DC-MD-VA	.48 M	.71	.60
DALLAS-FORT WORTH, TX	.86	.71	1.43
HOUSTON, TX	.75	.25	.40
BOSTON, MA	.37	1.08	.60
NASSAU-SUFFOLK, NY	ND	.72	.60
ST. LOUIS, MO-IL	7.27 M *	3.81 *	6.70 *
PITTSBURGH, PA	.38	.41	.45

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1981	1982	1983
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.61 M	.86	.67
MINNEAPOLIS-ST. PAUL, MN-WI	3.11 *	7.97 *	.71
ATLANTA, GA	.40	.59	.70 M
TOTAL SMSA'S > 2 MILLION : 16			

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE		
	1981	1982	1983
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.53	.91	.55
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.97	.92	.86
CLEVELAND, OH	.56	.42 M	.42 M
SAN DIEGO, CA	.90	1.15	.81
MIAMI, FL	.88	1.51	1.39
DENVER-BOULDER, CO	1.03 M	1.30 M	.58
SEATTLE-EVERETT, WA	.52	.82 M	7.57 M *
TAMPA-ST. PETERSBURG, FL	.68	1.10	1.01
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	1.00	.65	.55
PHOENIX, AZ	1.39	1.24	1.08
CINCINNATI, OH-KY-IN	.47 M	.51 M	.47 M
MILWAUKEE, WI	.36	.38	.63
KANSAS CITY, MO-KS	.43	.28	.33

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES AT A NEW MONITORING SITE.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	LEAD HIGHEST 1981	CONCENTRATION (UG/M3) MAXIMUM QUARTERLY AVERAGE 1982	 1983
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	.67	.99	.54
BUFFALO, NY	.38	.85	.69
PORTLAND, OR-WA	.58	1.63	1.37
NEW ORLEANS, LA	.25	.23	ND
INDIANAPOLIS, IN	.42	.49	.63
COLUMBUS, OH	.63 M	.66 M	.57 M
SAN JUAN, PR	1.02	1.69	1.30
SAN ANTONIO, TX	.76	.72	.56
FORT LAUDERDALE-HOLLYWOOD, FL	.23	.74	.71
SACRAMENTO, CA	.62	.55	.68

TOTAL SMSA'S 1 - 2 MILLION : 23

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	LEAD HIGHEST MAXIMUM QUARTERLY AVERAGE CONCENTRATION (UG/M3) 1981	1982	1983
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.29	.26	.51
SALT LAKE CITY-OGDEN, UT	ND	ND	ND
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.63	1.11	.93
MEMPHIS, TN-AR-MS	.54	1.30	1.17
LOUISVILLE, KY-IN	.75 M	1.16 M	.73 M
NASHVILLE-DAVIDSON, TN	.54	1.00	.54
BIRMINGHAM, AL	2.30 *	3.82 *	4.17 *
OKLAHOMA CITY, OK	.37	.41	.51
DAYTON, OH	.96 M	.73 M	.53 M
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.30	.40	ND
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.23	.33	.31
ALBANY-SCHENECTADY-TROY, NY	.39	.37	.30
TOLEDO, OH-MI	.19	.21	ND

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.25	.21	ND
JACKSONVILLE, FL	1.42	1.72	1.15
HARTFORD, CT	.48	.62 M	.42 M
ORLANDO, FL	.43	.35	ND
TULSA, OK	ND	.48	.69
AKRON, OH	.27 M	.22 M	.20 M
GARY-HAMMOND-EAST CHICAGO, IN	1.09	1.72 *	.62
SYRACUSE, NY	.32	.28	.34
NORTHEAST PENNSYLVANIA	.45	.56	.31
CHARLOTTE-GASTONIA, NC	.32	.79	ND
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.29	1.01	.76
RICHMOND, VA	ND	.26	.18
GRAND RAPIDS, MI	ND	ND	ND

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	ND	ND	2.12
WEST PALM BEACH-BOCA RATON, FL	.51	.32	ND
OMAHA, NE-IA	.97	1.59	1.23
GREENVILLE-SPARTANBURG, SC	.55	.79	ND
JERSEY CITY, NJ	.49	.71	.51
AUSTIN, TX	.67	ND	.53
YOUNGSTOWN-WARREN, OH	.27	.24	ND
TUCSON, AZ	.52	.58	.65
RALEIGH-DURHAM, NC	.33	.43	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.30	1.14	1.00
OXNARD-SIMI VALLEY-VENTURA, CA	.67	.46	.37
WILMINGTON, DE-NJ-MD	.40	1.24	1.81
FLINT, MI	.17	.15	ND

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

Table 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE		
	1981	1982	1983
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	1.13	.87	.70
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

5. TREND ANALYSIS FOR TEN URBANIZED AREAS

This chapter presents trends in ambient air quality for 1980 through 1983 in ten urbanized areas. The ten urbanized areas included in this analysis are Atlanta, GA; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Houston, TX; Los Angeles-Long Beach, CA; New York-NY-Northeastern NJ; Philadelphia, PA-NJ; Portland, OR-WA; and St. Louis, MO-IL. These cities were selected because they were amoung the largest cities in each of the EPA Regions. Where sufficient data were available, trends are presented for the criteria pollutants TSP, SO_2, CO, NO_2, O_3, and Pb.

The air quality data used in the trend statistics in this section were obtained from the EPA National Air Data Bank (NADB). Additionally, some data were taken from State annual reports. The monitoring sites used for the trend analysis were required to satisfy the historical continuity criteria of 3 out of 4 years. Furthermore, each year with data generally had to meet the annual data completeness criteria as described in Section 2.1.

Although some of the ten urbanized areas had sufficient data to prepare area trends for the nine year period (1975 through 1983), the period covered by the national trends discussed in Section 3, several of the urbanized areas did not have sufficient data to meet the 7 of 9 year data completeness criteria. As a result of this situation and considering the fact that the ten urbanized areas began establishing fixed long-term National Air Monitoring Stations in 1980, it was decided to begin the urbanized area trends analysis in 1980. In subsequent years, 1980 will be retained as the starting year.

The trends analyses are based on monitoring sites located within the boundaries (except for O_3) of the urbanized areas included in the 1980 Census of Population Report prepared by the U.S. Bureau of Census.[1] The report describes an urbanized area as consisting of a central city or cities, and surrounded closely settled territory (urban fringe). Since the maximum O_3 concentrations generally occur downwind of an urbanized area, the downwind sites located outside of the urbanized area boundaries were also used in the trends analysis.

Maps of the appropriate urbanized area are included as part of the discussions on urban area trends. The maps include county and urban area boundaries and were obtained from the Bureau of Census maps, while the city boundaries are the best estimates of the actual city borders. The locations of the monitoring sites shown on the maps are for sites having at least 3 years of data during 1980-1983 and which were used in the trend analysis. The maps are presented for illustrative purposes to show the spatial distribution of monitoring sites.

Figure 5-1 shows the plotting convention used in trends analysis. For 1980-1983, the maximum and minimum values as well as the composite average of the sites used in the trends are shown. The maximum and minimum values are measured concentrations, while interpolated values for missing years were used to calculate the appropriate average. Table 5.1 shows the air quality statistics used in the trend analyses for the ten cities. It should also be noted on the TSP trend plots for all cities, except Houston, that the composite averages for 1980-1982 are connected by dotted lines. As previously explained in Section 3.1.1, EPA has found that TSP data collected in 1980 and 1981 may be biased high due to the glass fiber filter used during these years. The apparent decrease in TSP concentrations between 1981 and 1982 can be partially attributed to a change in the filters. In Houston during 1981 and 1982, a combination of several different types of filters were used which may have resulted in an unknown bias.[2]

The air quality data and trends presented in this section should not be used to make direct city to city comparisons since the mix, configuration, and number of sites comprising the area network are different. Furthermore, other parameters such as population density, transportation patterns, industrial composition, emission inventories, and meteorological characteristics also need to be taken into consideration.

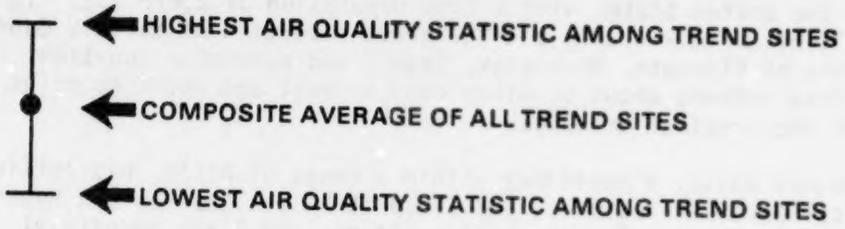

HIGHEST AIR QUALITY STATISTIC AMONG TREND SITES
COMPOSITE AVERAGE OF ALL TREND SITES
LOWEST AIR QUALITY STATISTIC AMONG TREND SITES

FIGURE 5-1. ILLUSTRATION OF PLOTTING CONVENTIONS FOR RANGES USED IN URBANIZED AREA TREND ANALYSIS.

Table 5-1. Air Quality Trend Statistics and Their Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	TREND STATISTICS	PRIMARY NAAQS CONCENTRATION
Total Suspended Particulate	annual geometric mean	75 ug/m^3
Sulfur Dioxide	annual arithmetic mean	(0.03 ppm) 80 ug/m^3
Carbon Monoxide	second highest nonoverlapping 8-hour average	(9 ppm) 10 mg/m^3
Nitrogen Dioxide	annual arithmetic mean	(0.053 ppm) 100 ug/m^3
Ozone	second highest daily maximum 1-hour average	0.12 ppm
Lead	maximum quarterly average	1.5 ug/m^3

ug/m^3 = micrograms per cubic meter

ppm = parts per million

mg/m^3 = milligrams per cubic meter

5.1 BOSTON, MASSACHUSETTS URBANIZED AREA

The Boston urbanized area, located in the eastern part of the State, is the largest urbanized area in the State of Massachusetts and the eighth largest in the United States with a 1980 population of 2,678,762. It includes all of Suffolk County and the greater portion of Norfolk County plus portions of Plymouth, Middlesex, Essex, and Worcester Counties. The urbanized area extends about 51 miles east to west and about 46 miles north to south at the greatest distances.

The Boston basin, a territory within a range of hills, has rolling topographical physical features, and is split by the Charles and Mystic Rivers. Because of the confinement, many tall buildings and light industrial, commercial, and residential land use complexes are in close proximity of each other. Numerous small factories and a great diversification of industries are found in this area including electrical, food, printing and publishing, transportation equipment, fabricated metal, and rubber products. Boston is the chief United States' Atlantic Ocean fishing port. A large network of railroads and truck lines serve this port.

The meteorology of the area is complex. Prevailing winds are from the northwest in the winter and southwest in the summer. During the summer, the land, sea-breeze effect allows pollutants to be transported out over the sea and then returned to the inland area.

The locations of the monitors used in the pollutant trend graphs are provided in Figure 5-2 and 5-3. The trend graphs are displayed in Figure 5-4.

5.1.1 TSP Trends

Twenty-two sites were operated during the period 1980-1983, six sites (three NAMS) had 3 or more years of valid data. There was a 7 percent decline in the highest TSP levels and a 16 percent decline in the composite average concentrations comparing the 1980 to the 1983 levels. The trend is similar to the national trends. The composite average levels for the three NAMS showed an 11 percent decline during this period. The lowest TSP concentrations were measured at a site in a residential area while the highest concentrations were measured in the industrial areas of Boston. The overall improvement in the TSP air quality between 1980 and 1983 was 16 percent. Unlike the national trend, there was no decrease in the geometric mean from 1981 to 1982. As noted in Section 3.1.1, some of the national decrease in TSP from 1981 to 1982 may be attributed to a change in the filters. In the case of the Boston urbanized area, the lack of a decrease may be due to the drier conditions in the northeast in 1982 than in 1981.[3]

5.1.2 Pb Trends

There were four sites that reported data during the years of 1980-1983; however, no site met the criteria of 3 years of complete data. The data from two sites that reported in 1982 and 1983 indicate the Pb levels are lower in 1983 than in 1982, similar to the national trend.

5.1.3 SO_2 Trends

Eighteen SO_2 sites were operated between 1980 and 1983. Figure 5-4 shows the trend for five sites (three NAMS) meeting the trend criteria. Comparing the 1980 composite annual mean to the 1983 value, there was a 23 percent decline while the decline seen at the national level is 15 percent. The high rate of decline in the SO_2 levels for Boston may be related to meteorology and fuel conservation. The highest levels were measured at a site located in the industrial area of Boston and the lowest levels were measured at a site located in a residential area of Medfield.

5.1.4 O_3 Trends

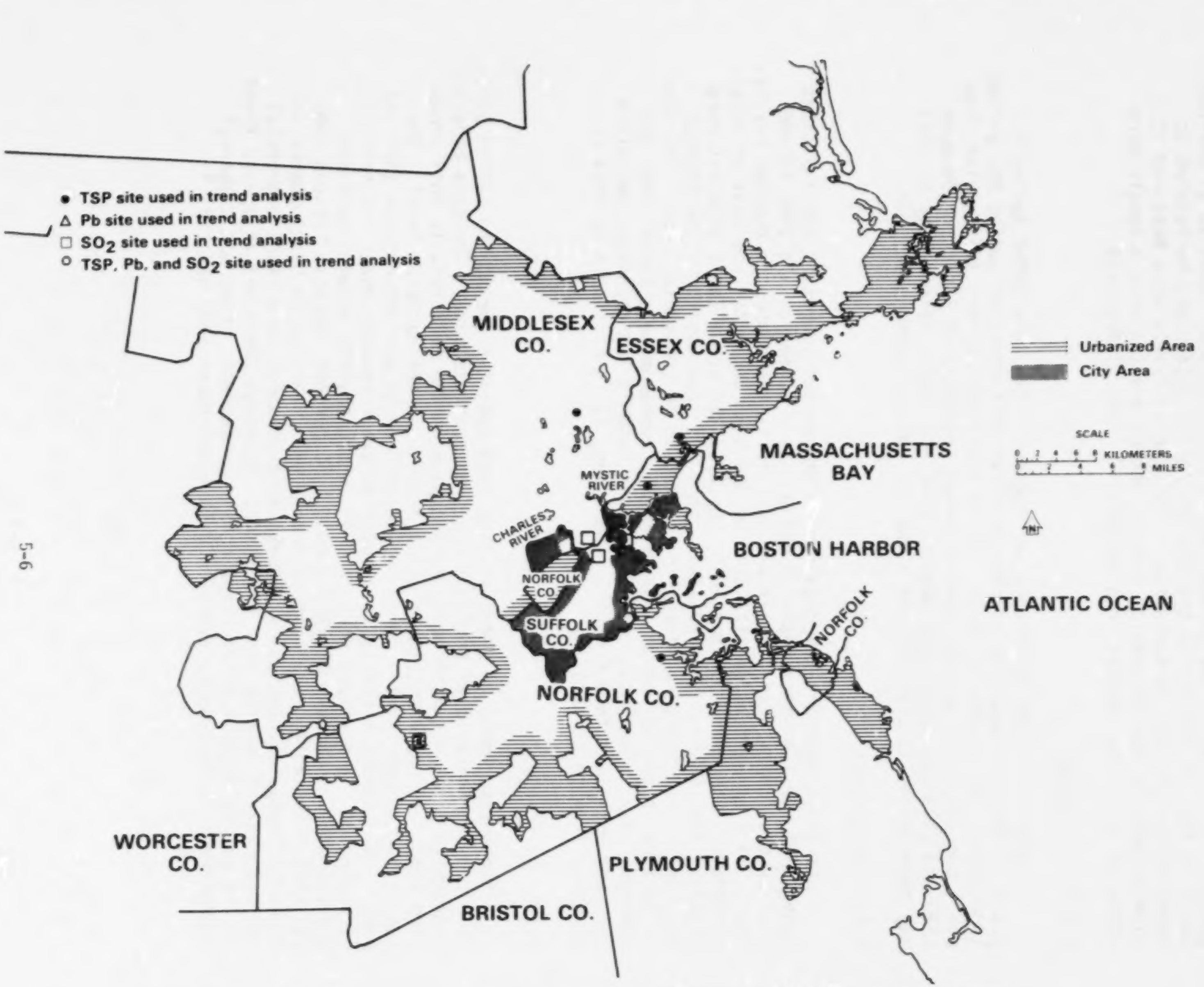
Figure 5-3 shows the trends for the two sites (one NAMS) having 3 years of complete data out of the ten sites that operated during the period 1980-1983. The trends in the O_3 levels fluctuated during this period; however, the composite average levels showed increases of 9 percent between 1980 and 1983 and 21 percent between 1982 and 1983. Meteorology in 1983 may have partially affected the higher O_3 levels during this year.

5.1.5 NO_2 Trends

Six sites reported NO_2 data during the period 1980-1983 and two sites (one NAMS) had 3 or more years of valid data. Comparing the 1980 to the 1983 levels, there was a 38 percent decline in the composite average levels. There was a 21 percent decline seen at the NAMS NO_2 site. To have an interpolated NO_2 concentration for 1980, the reported value for a site was used although the number of observations was lower than desired. The highest NO_2 levels were measured at a site located in an industrial area. The rate of decline in the NO_2 levels for Boston is approximately three times the national rate. The reason for the higher rate is not apparent, and since the rate was determined from only two sites, it is difficult to draw conclusions from these data.

5.1.6 CO Trends

Three (two NAMS) of the ten sites that operated during the period 1980-1983 met the criteria of having 3 years of complete data. The data reported from these three sites indicate an increase in the CO levels in this urbanized area. In contrast, there was a decline at the national level. The composite average levels showed an increase of 36 percent between 1980 and 1983. This upward trend is attributed to urban redevelopment and traffic rerouting as the monitors were in areas where traffic volume increased significantly. The two CO NAMS showed a 30 percent increase between 1980 and 1983. Generally, the highest levels were measured in heavy commercial areas of Boston and the lowest levels were measured in a light commercial and residential complex area of Boston. Although there was an upward trend in the second highest nonoverlapping 8-hour average, there was a general improvement in the annual average CO levels between 1980 and 1983.[4]



● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N
MIDDLESEX CO.
ESSEX CO.
MASSACHUSETTS BAY
MYSTIC RIVER
CHARLES RIVER
BOSTON HARBOR
NORFOLK CO.
SUFFOLK CO.
ATLANTIC OCEAN
NORFOLK CO.
NORFOLK CO.
WORCESTER CO.
PLYMOUTH CO.
BRISTOL CO.

FIGURE 5-2. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN BOSTON, MA, 1980-1983.

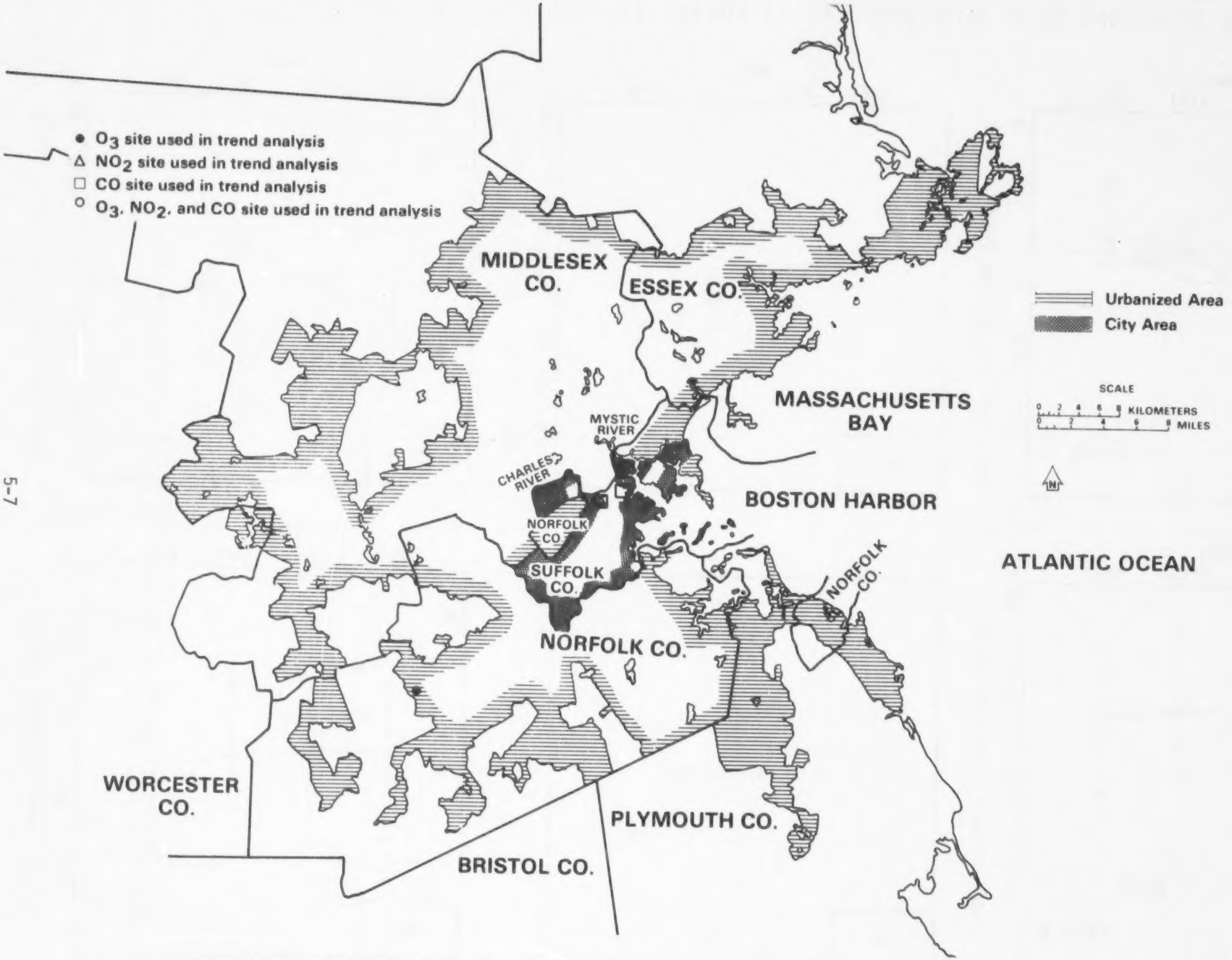

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MIDDLESEX CO.
ESSEX CO.
MASSACHUSETTS BAY
MYSTIC RIVER
CHARLES RIVER
BOSTON HARBOR
NORFOLK CO.
SUFFOLK CO.
NORFOLK CO.
NORFOLK CO.
ATLANTIC OCEAN
WORCESTER CO.
PLYMOUTH CO.
BRISTOL CO.
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N

FIGURE 5-3. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN BOSTON, MA, 1980-1983.

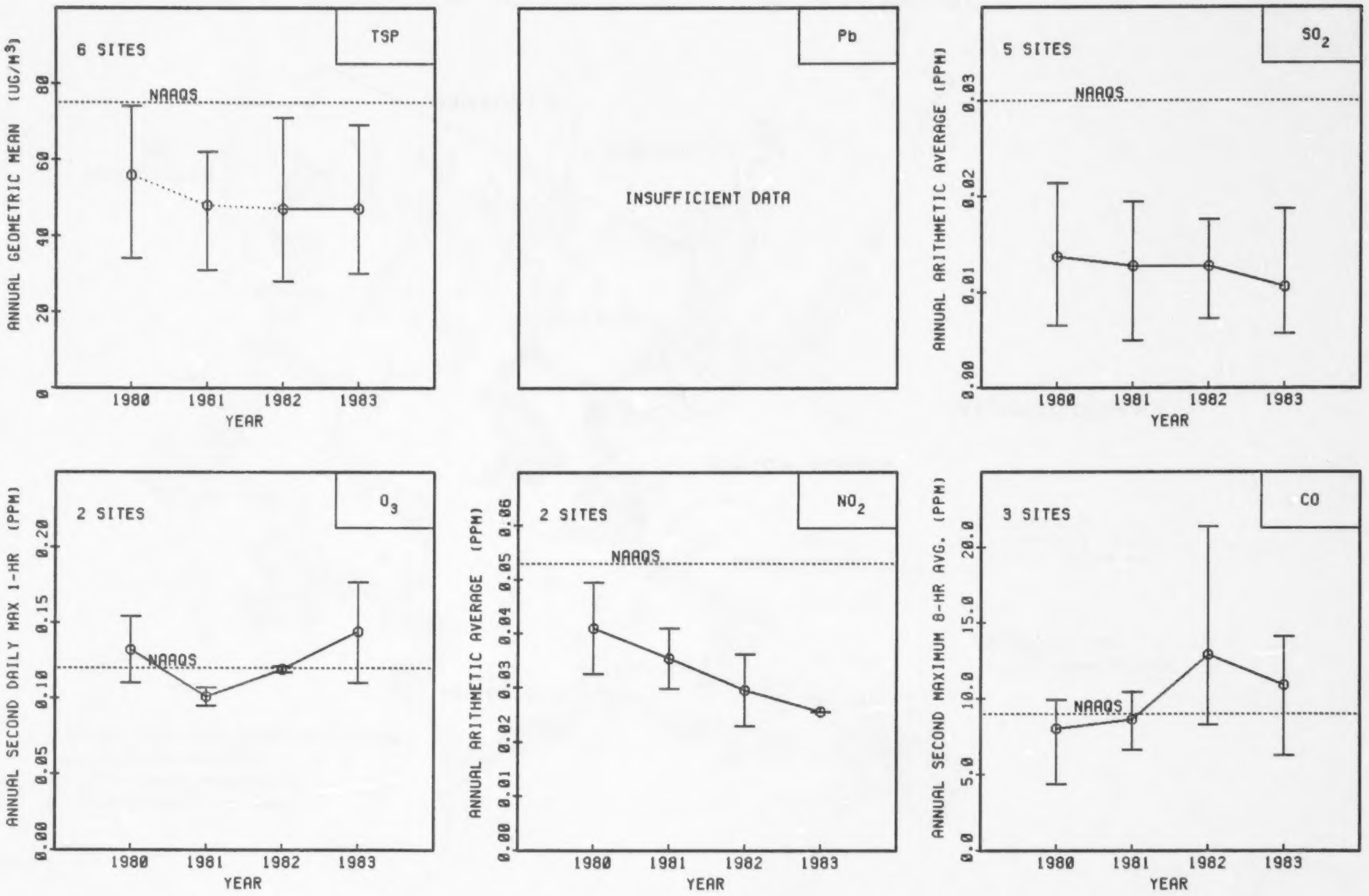


FIGURE 5-4. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE BOSTON, MA URBANIZED AREA, 1980 - 1983.

5.2 NEW YORK, NEW YORK-NORTHEASTERN NEW JERSEY URBANIZED AREA

The New York urbanized area is the largest urbanized area in the United States with a 1980 population of 15,590,274. It includes all of Essex, Hudson, and Union Counties in New Jersey; all of Bronx, Kings, Nassau, New York, Queens, and Richmond Counties in New York; parts of Bergen, Middlesex, Monmonth, Morris, Ocean, Passaic, Somerset, and Sussex Counties in New Jersey; and parts of Putnam, Rockland, Suffolk, and Westchester Counties in New York. At its greatest distance, the urbanized area extends about 105 miles east to west and about 110 miles north to south.

The urbanized area is located at the mouth of the Hudson River in the northeastern part of the United States. As a major ocean port, it is the busiest in the United States. Industries have concentrated in the urbanized area because of the proximity to major markets and the easy access to transportation facilites. This urbanized area is the leading manufacturing area in the United States. The largest manufacturing industries are apparel and other finished products; printing, publishing, and allied industries; food products; machinery; chemical and allied products; fabricated metal products; textile products; leather and leather products; paper products; auto and aircraft production; and shipbuilding.

The urbanized area is close to the path of most frontal systems which move across the United States. Extremes of hot weather which may last up to 1 week are associated with air masses moving over land from a Bermuda high pressure system. Extremes in cold weather are from rapidly moving outbreaks of cold air moving southeastward from the Hudson Bay region. The average rainfall is around 41 inches per year.

The maps showing the locations of the monitoring sites used in the trend analysis are shown in Figure 5-5 and Figure 5-6. The trend graphs for the pollutants are shown in Figure 5-7.

5.2.1 TSP Trends

There were 103 sampling sites (52 in New Jersey and 51 in New York) that reported TSP data during 1980-1983, and of these 103 sites, 54 met the 3 out of 4-year data completeness criteria (29 in New Jersey and 25 in New York). Figure 5-5 shows the location of the 54 sites, and Figure 5-7 shows the trend graph of the 54 sites for 1980-1983 in which the composite average decreased 18 percent as compared to the national average of 22 percent for the same period. The highest measured concentrations were in the heavily industrialized areas of New Jersey and the lowest concentrations were in the residential areas of Long Island. Some of the decrease from 1981 to 1982 can be attributed to a change in the filters (see Section 3.1.1).

5.2.2 Pb Trends

Pb was sampled at 22 sites during 1980-1983. Only one site had data for 3 years, but the chemical analyses have not been completed for 1984. Therefore, no trends are depicted for Pb. The available data show maximum quarterly concentrations of around 0.5 to 1.2 ug/m^3 at traffic-oriented sites and 0.3 to 0.7 at non-traffic oriented sites. The highest concentrations during 1980-1983 were measured in New Brunswick, NJ near a battery manufacturing facility (2.12 ug/m^3 in 1983.)

5.2.3 SO_2 Trends

There were 52 sites which reported some data in the period 1980-1983, but only 26 sites met the data completeness criteria. The SO_2 levels decreased 4 percent as compared to the national average of 15 percent (Figure 5-7). The highest concentrations during the period were measured in New York County (Manhattan) and are attributed to apartment buildings using oil for heating. While the overall annual mean levels fell 4 percent, the composite New York City borough sites decreased about 10 percent, the remaining New York county sites 4 percent and the composite of the New Jersey sites increased 2 percent.

5.2.4 O_3 Trends

A total of 27 sites monitored for O_3 during 1980-1983 and 12 of these sites met the criteria for completeness and were used in the trend analysis. The trends follow the national pattern in that there was a decrease for 1980-1982 and an increase in 1983. From 1980-1983, the New York O_3 levels increased 7 percent while the national levels were unchanged for the same period. Between 1982 and 1983, the O_3 levels increased 18 percent. The composite average concentrations were above the NAAQS for each year during 1980-1983, and except for 1982, all the minimum trend sites were also above the NAAQS.

5.2.5 NO_2 Trends

The NO_2 trends for seven sites that met the completeness criteria in the urbanized area show a slight decrease from 1980 to 1981, and then increases for 1982 and 1983. The seven sites are a subset of the 21 sites that reported data for 1980-1983. The overall trend for 1980-1983 was a 7 percent increase, which is the reverse of the national decline of 12 percent. Part of this increase has been attributed to the decline in usage of the mass transit system and an increase in vehicular traffic.

5.2.6 CO Trends

There were 23 sites which measured CO during 1980-1983 and 15 sites met the data completeness criteria. The CO composite average decreased 6 percent as compared to the national decrease of 11 percent for the same period. The highest concentrations were measured in street canyons in Manhattan and Jersey City. The New Jersey and New York portions of the urbanized area showed almost identical decreases with 5 and 6 percent, respectively.

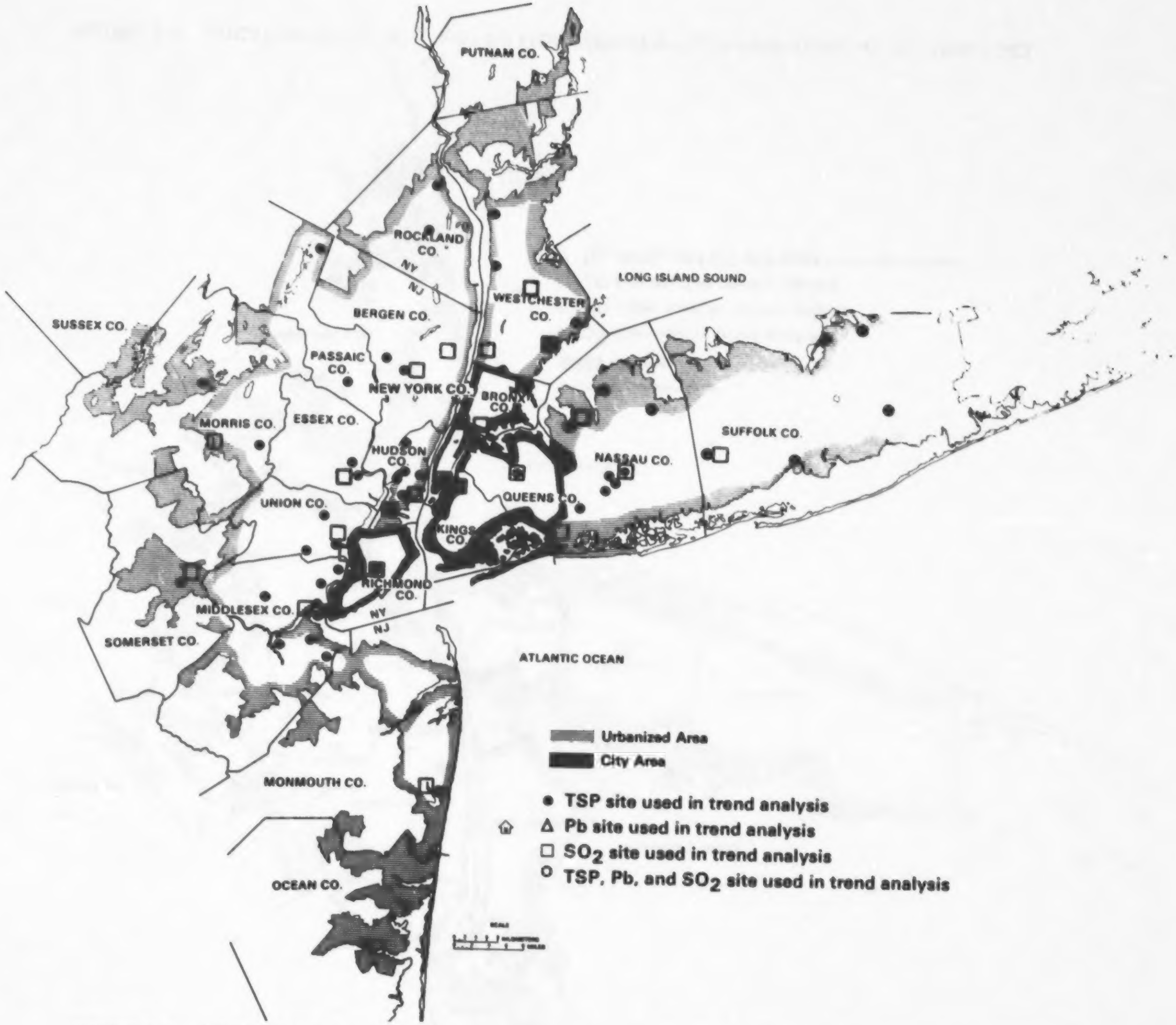

PUTNAM CO.
ROCKLAND CO.
NY
NJ
WESTCHESTER CO.
LONG ISLAND SOUND
SUSSEX CO.
BERGEN CO.
PASSAIC CO.
NEW YORK CO.
BRONX CO.
MORRIS CO.
ESSEX CO.
HUDSON CO.
NASSAU CO.
SUFFOLK CO.
UNION CO.
QUEENS CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
NY
NJ
SOMERSET CO.
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
Urbanized Area
City Area
● TSP site used in trend analysis
Δ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis

FIGURE 5-5. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN NEW YORK, NY-NJ, 1980-1983.

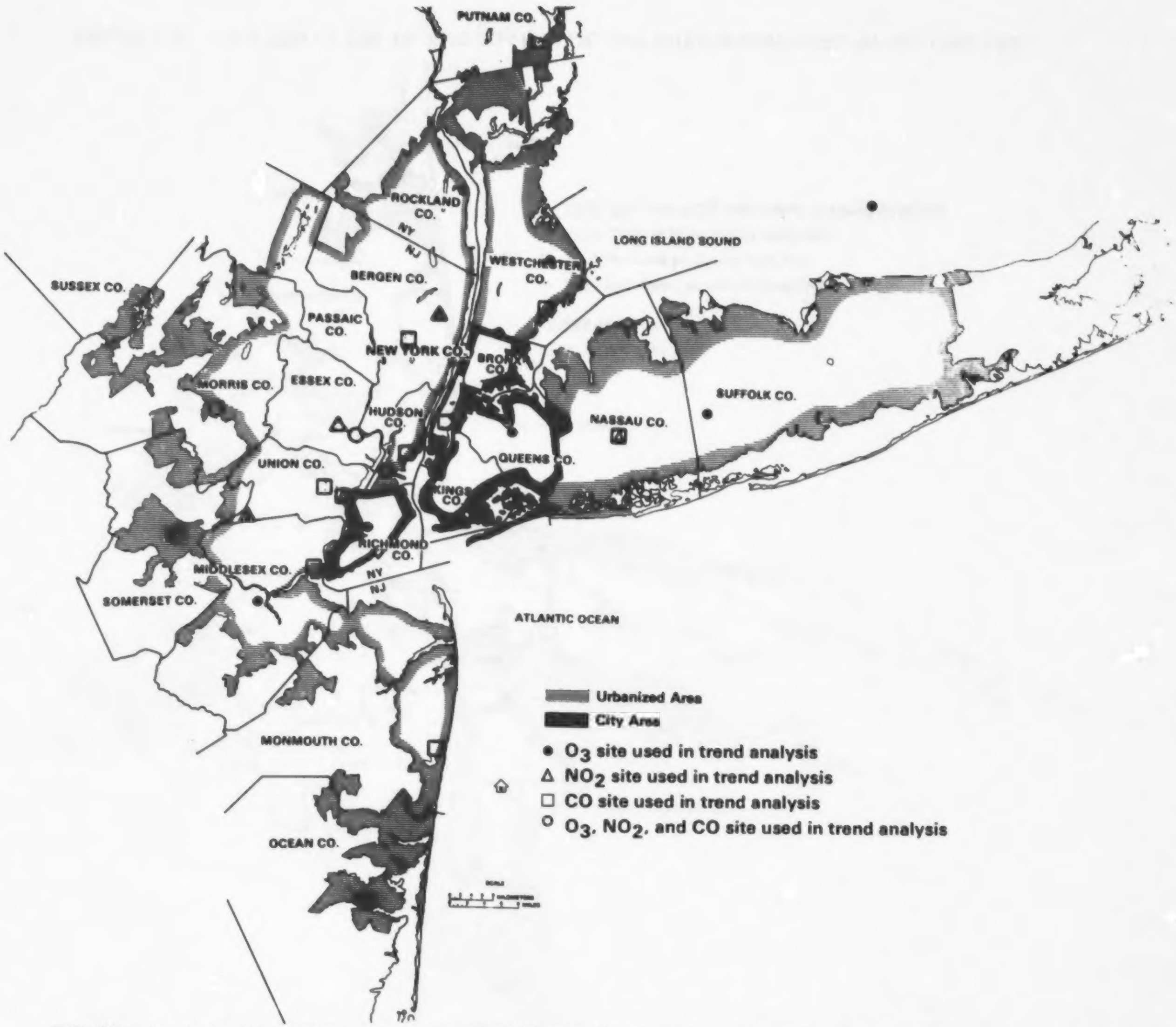

PUTNAM CO.
ROCKLAND CO.
NY
NJ
WESTCHESTER CO.
LONG ISLAND SOUND
SUSSEX CO.
BERGEN CO.
PASSAIC CO.
NEW YORK CO.
BRONX CO.
MORRIS CO.
ESSEX CO.
HUDSON CO.
NASSAU CO.
SUFFOLK CO.
UNION CO.
QUEENS CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
SOMERSET CO.
NY
NJ
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
Urbanized Area
City Area
● O3 site used in trend analysis
△ NO2 site used in trend analysis
☐ CO site used in trend analysis
○ O3, NO2, and CO site used in trend analysis
SCALE

FIGURE 5-6. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN NEW YORK, NY-NJ, 1980-1983.

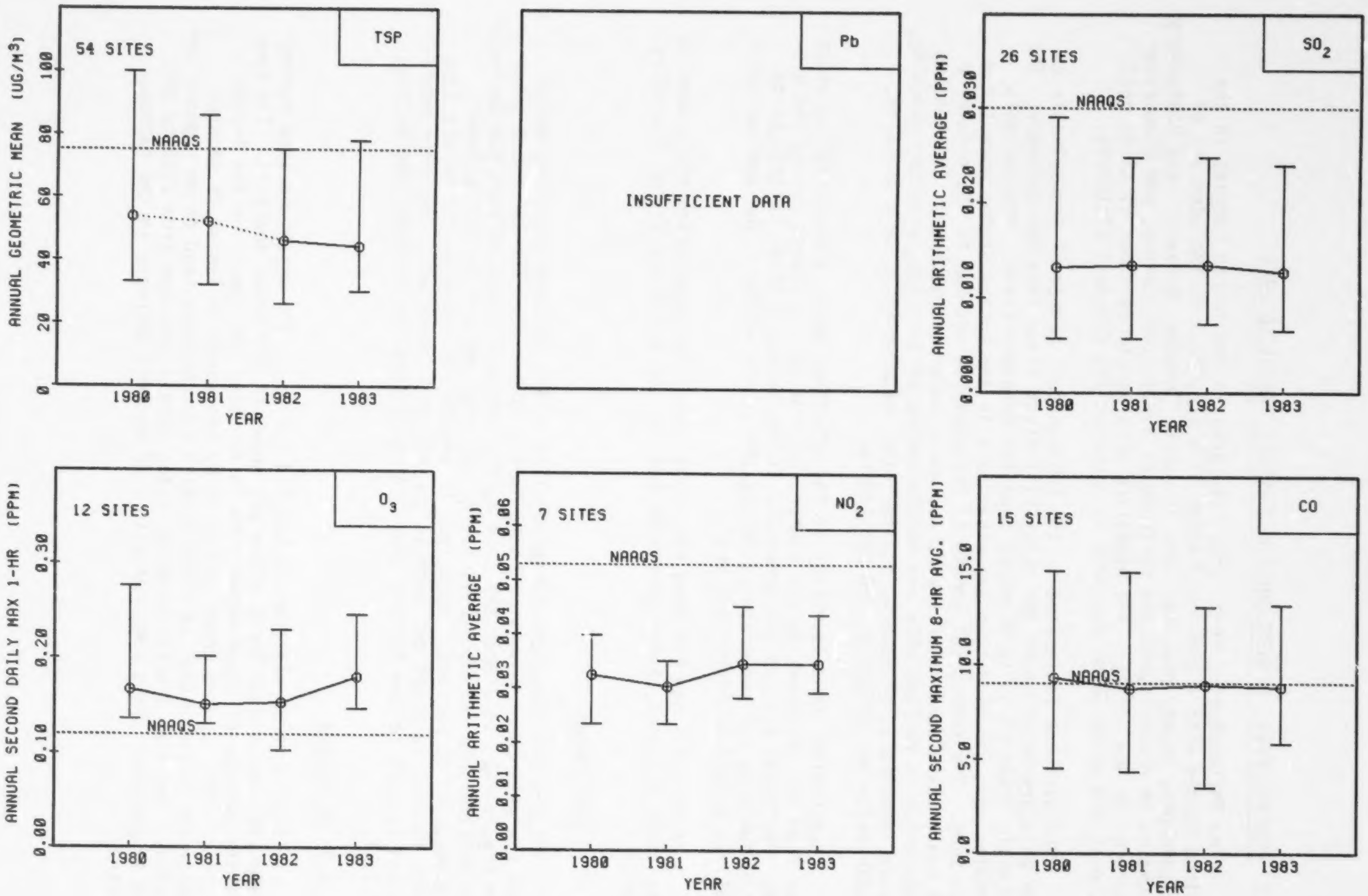


FIGURE 5-7. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE NEW YORK, NY-NJ URBANIZED AREA, 1980 - 1983.

5.3 PHILADELPHIA, PENNSYLVANIA-NEW JERSEY URBANIZED AREA

The Philadelphia, PA-NJ urbanized area is the fourth largest in the United States with a 1980 population of 4,112,933. It includes all of Philadelphia County plus portions of Bucks, Chester, Delaware, and Montgomery Counties in Pennsylvania and portions of Burlington, Camden, and Gloucester Counties in New Jersey. The urbanized area stretches about 65 miles east to west and about 50 miles north to south at its greatest distances.

Philadelphia is located in the southeastern corner of Pennsylvania on the Delaware River where the Schuylkill River flows into the Delaware. The Atlantic Ocean is 85 to 90 miles down the Delaware River. Philadelphia handles more shipping than any other port in the United States except for New York. The industrial growth of Philadelphia was due to its proximity to coal, petroleum, water power, and other natural resources. The leading industries in Philadelphia are manufacturing of textiles, carpets, clothing, paper, chemicals, glassware, oil refining, metalworking, ship building, sugar refining, printing, and publishing.

Concerning the meteorology of the urbanized area, the prevailing winds are from the southwest in the summer and from the northwest during the winter. Maritime air and the proximity to the Delaware River contribute to high humidity and temperatures during the summer months. The average rainfall is around 42 inches per year.

Figures 5-8 and 5-9 show the locations of the monitoring sites used in the trend analysis, and Figure 5-10 depicts the trend graphs for the pollutants.

5.3.1 TSP Trends

Figure 5-8 shows the location of 26 of the 36 sampling sites which met the data completeness criteria during 1980-1983. The TSP trend shown in Figure 5-10 is almost the same as the national trend in that the decrease in Philadelphia for 1980-1983 was 23 percent compared to the national decrease of 22 percent. Also, the 16 percent decrease in TSP levels from 1981 to 1982 is about the same as the national trend which has been attributed in part to the filters used for collecting the samples (see Section 3.1.1).

5.3.2 Pb Trends

There were 28 sites which sampled for Pb in the urbanized area during 1980-1983 and six of these sites are shown in the trend analysis. The composite average of these sites show an increase each year for the 4-year period. This upward trend is caused by one source-oriented Pb sampler which is located close to a plant which manufactures lead oxide pigment for paint. The five traffic oriented sites show a decrease from 1980 to 1983 of 27 percent. This compares with a 34 percent decrease in the national trend.

5.3.3 SO_2 Trends

The SO_2 concentrations were measured at 23 sites in the urbanized area. Ten of these sites met the data completeness criteria and were used in the trend analysis. The 25 percent decline from 1980 to 1983, while greater than the national decrease of 15 percent, appears to be consistent with Philadelphia's preliminary estimates of changes in emissions.[5] Area sources and refineries contributed to the SO_2 levels measured in the urbanized area.

5.3.4 O_3 Trends

Of the 11 sites that monitored O_3 in the urbanized area during 1980-1983, seven sites were selected for the trend analysis based on data completeness. The sites follow the national trend in decreases from 1980-1982 followed by an increase in 1983. The result was a 15 percent overall decrease from 1980-1983, and a 10 percent increase between 1982 and 1983. Meteorological conditions in 1983 may have been more favorable for O_3 formation than in 1981 and 1982.

5.3.5 NO_2 Trends

Eleven sites monitored NO_2 during 1980-1983, and the trends for the seven sites meeting the completeness criteria are shown in Figure 5-9. The highest arithmetic average and the composite average of the seven sites were about the same for 1980-1983. The actual decrease in the composite average was 1 percent, which was less than the national decrease of 12 percent. The effect of mobile sources (which account for about 50 percent of the nitrogen oxide emissions) on the NO_2 sites may be the reason for the relatively unchanged NO_2 trends. Increasing traffic densities in the vicinity of the sites and decreasing NO_x emissions due to the Federal Motor Vehicle Emission Control Program could account for the stable trend.

5.3.6 CO Trends

Carbon monoxide was measured at 19 sites during 1980-1983 and six of these were used in the trend analysis. The composite CO levels at the six sites showed an increase from 1980 to 1981 and then decreases from 1981-1983. There was an overall decrease of 13 percent from 1980 to 1983 which compares to the national decrease of 11 percent. The highest concentrations in 1982 and 1983 were from a new microscale site which had insufficient data to be included in the trend analysis.

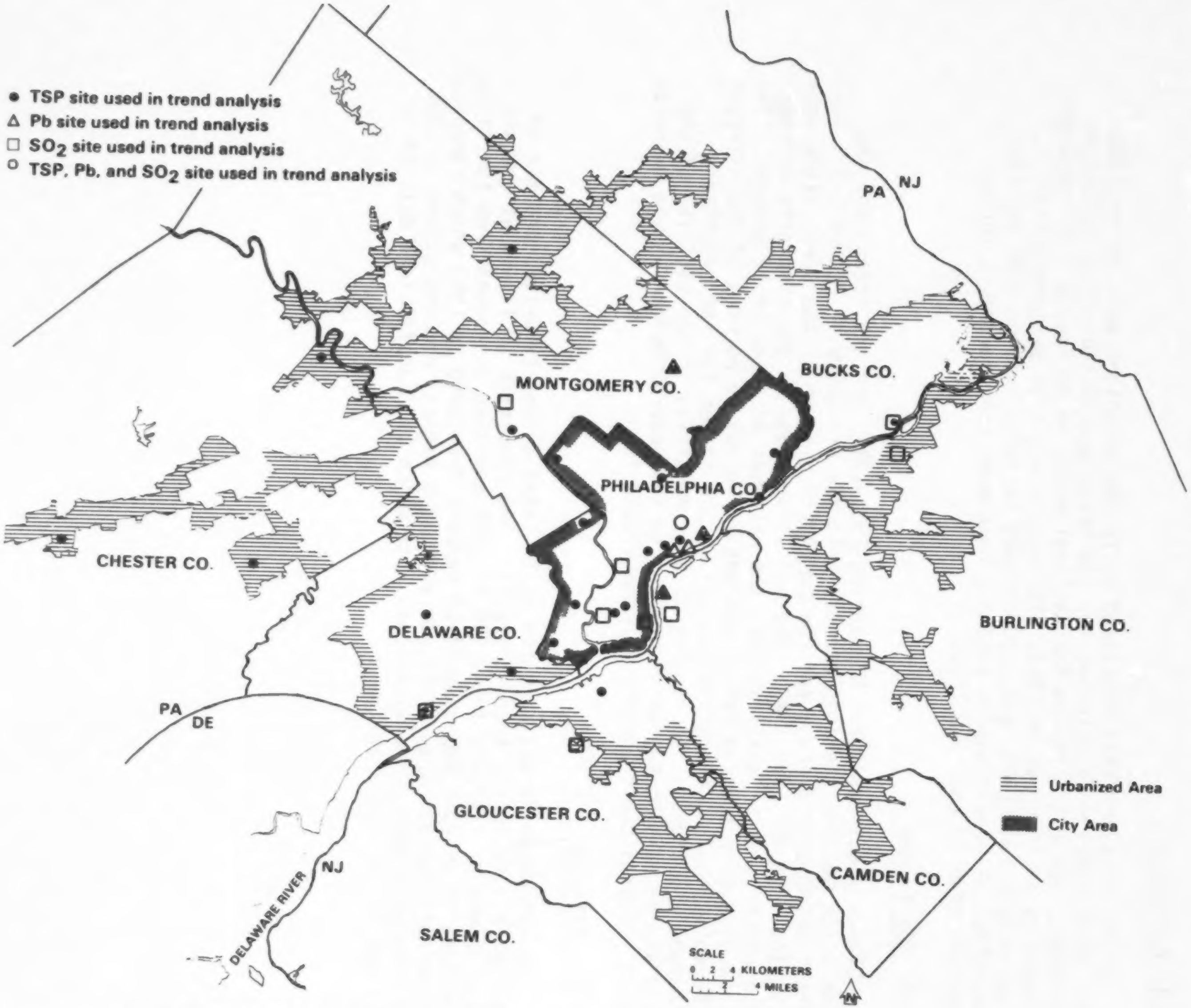

● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
PA
NJ
MONTGOMERY CO.
BUCKS CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
SALEM CO.
NJ
DELAWARE RIVER
Urbanized Area
City Area
SCALE
0 2 4 KILOMETERS
2 4 MILES
N

FIGURE 5-8. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN PHILADELPHIA, PA-NJ, 1980-1983.

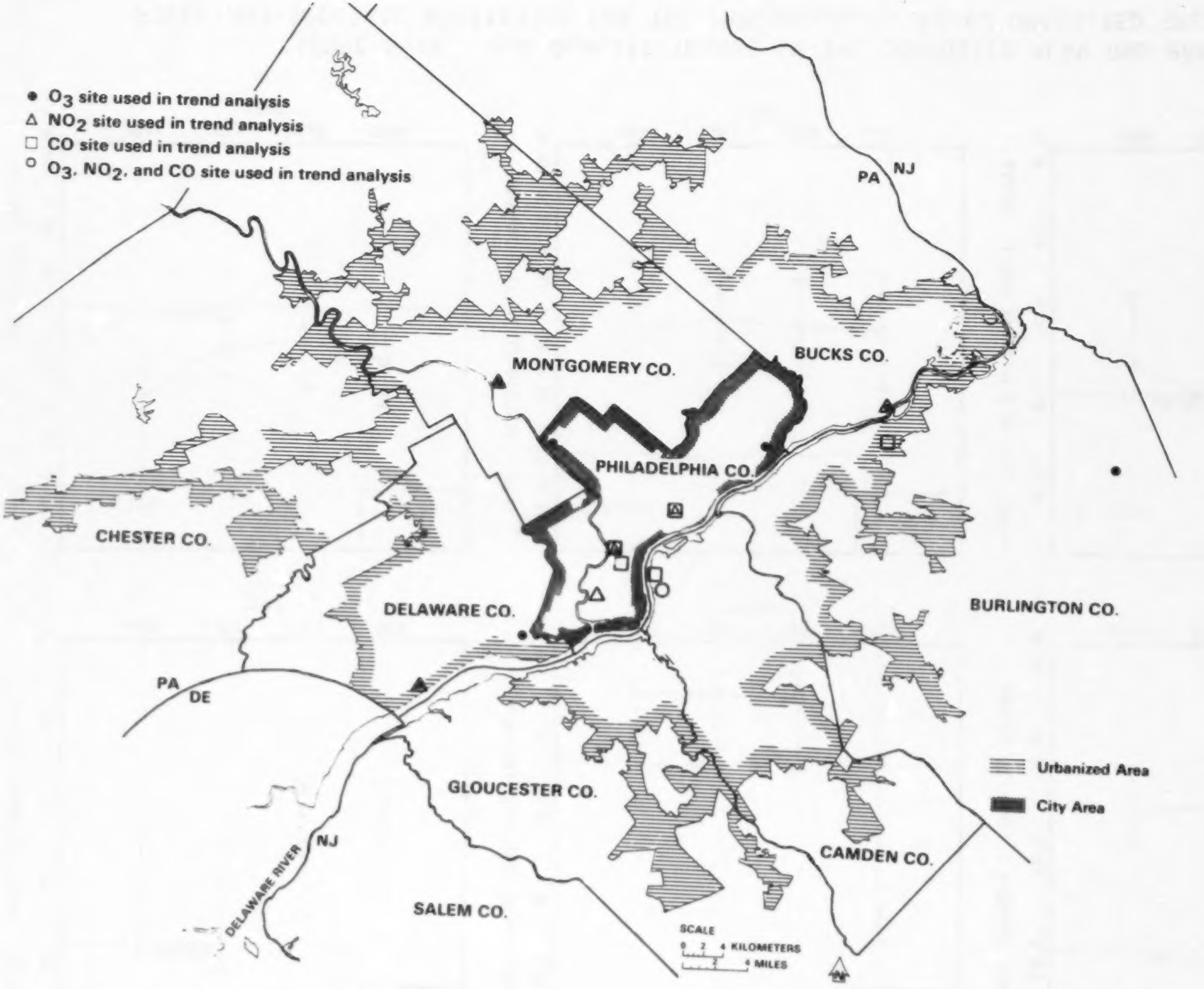

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
PA
NJ
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
NJ
DELAWARE RIVER
SALEM CO.
SCALE
0 2 4 KILOMETERS
2 4 MILES
Urbanized Area
City Area

FIGURE 5-9. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN PHILADELPHIA, PA—NJ, 1980-1983.

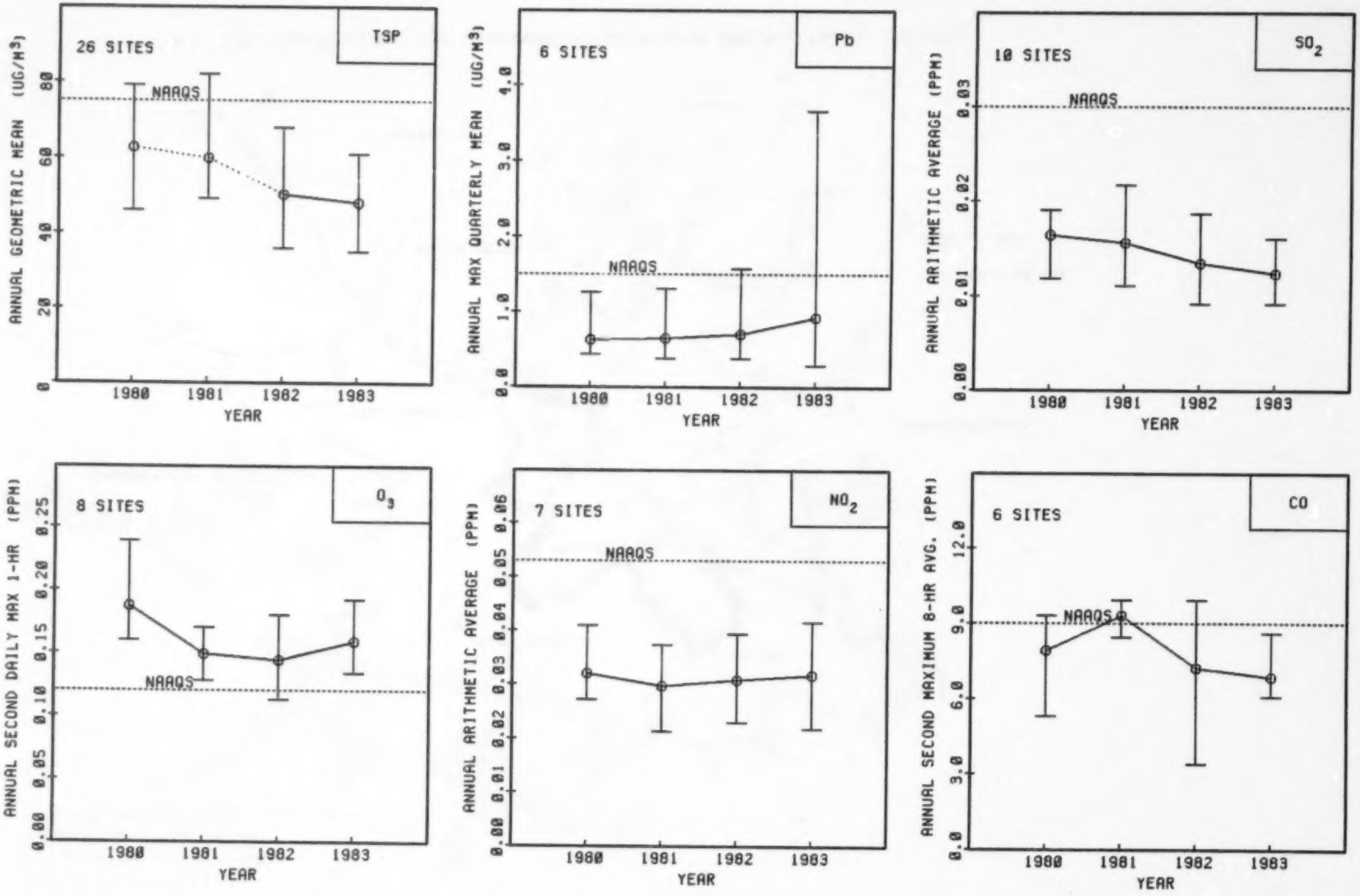


FIGURE 5-10. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE PHILADELPHIA, PA-NJ URBANIZED AREA, 1980 - 1983.

5.4 ATLANTA, GEORGIA URBANIZED AREA

Atlanta, the capital of Georgia and its largest city, is located in the north-central part of the State. The urbanized area of Atlanta is the most populous area between Washington, DC and New Orleans with a 1980 population of 1,613,357. The area extends into ten counties and measures approximately 40 miles north to south and 35 miles east to west. The majority of the people in the urbanized area live in Fulton, de Kalb, and Cobb Counties. Approximately 500 square miles of land area are included in this urbanized area.

The city is the financial and commerical capital of the southeast, the transportation and commercial center of the region, and an important distribution, manufacturing, educational, and medical center. Since its location is at the southern extreme of the Appalachian Range, it has become the gateway through which most overland and air traffic must pass from the eastern seaboard to the west. Atlanta is a rapidly growing and expanding area. The population increased by 37 percent since 1970. Atlanta has moderate summer and winter weather, with the summer winds from the northwest and winter winds fluctuating from southwest to northwest. In spite of abundant rainfall, serious dry spells occur during most years.

The locations of the monitors used in the pollutant trend graphs are provided in Figures 5-11 and 5-12. The trend graphs are shown in Figure 5-13.

5.4.1 TSP Trends

Nineteen sites were operating for some time during the period 1980-1983 and nine of the sites (5 NAMS) had at least 3 years of valid data. The general location of these sites is shown on the map in Figure 5-11. Five of the nine sites were within the Atlanta city limits.

The composite average for the nine sites used to indicate the TSP trend for Atlanta showed a 11 percent decline, while the national decline was 22 percent. The 1980 composite average was below the secondary NAAQS (60 ug/m^3) and the highest annual mean was below the primary NAAQS for all years except 1981. The lower rate of air quality improvement in Atlanta compared to the national level may be due to its rapid growth and to the long dry periods in 1982 and 1983. The higher TSP levels in 1980 and 1981 are probably due in part to the filters (Section 3.1.1). The highest levels were measured at a site located in a heavy commercial area and the lowest levels were measured at sites located in light commercial and residential areas.

5.4.2 Pb Trends

One Atlanta Pb site reported data during the 4-year period between 1980 and 1983, and met the data completeness criteria. The location of the Pb site is shown on the map in Figure 5-11.

The Pb levels fluctuated between 1980 and 1983; however, the 1983 highest quarterly level was 50 percent lower than the 1980 highest quarterly level (Figure 5-13). The 1980 and 1983 Pb levels at the Atlanta site were similar to the national composite levels. It is difficult to provide any conclusive statement about the Pb trends due to the sparsity of data.

5.4.3 SO_2 Trends

Atlanta operated one monitor during 1980 to 1983 and was relocated to a different site in 1982. Neither site met the data completeness criteria, and therefore, no trend analysis was conducted.

5.4.4 O_3 Trends

There were two NAMS O_3 sites that met the criteria of having 3 or more valid years of data and the general location of these sites is shown on the map in Figure 5-12. For this urbanized area, the ozone season was assumed to run from March to November. There was a fluctuating trend between 1980 and 1982 and a 31 percent increase between 1982 and 1983, resulting in a 34 percent overall increase in the O_3 levels between 1980 and 1983. The composite average of the second highest daily maximum hour was above the NAAQS for 3 out of the 4 years. Figure 5-13 shows the O_3 trends. The meteorology in 1983 may have been more favorable for ozone formation than in 1981 and 1982.

5.4.5 NO_2 Trends

There were six sites (two continuous monitoring sites) operating in 1980. Only two continuous monitoring sites were operated after 1980, neither of which met the data completeness criteria required for inclusion in the trend analysis.

5.4.6 CO Trends

There were six sites in the urbanized area and five of these sites met the criteria of 3 out of 4 valid years of data. The general location of these CO trend sites is shown on the map in Figure 5-12. Data from these five sites indicated a 20 percent decline in the Atlanta CO levels as compared to 11 percent nationally during this period. The greater percentage reduction than the national average could be attributed to the initiation of an automotive inspection maintenance program in 1981.

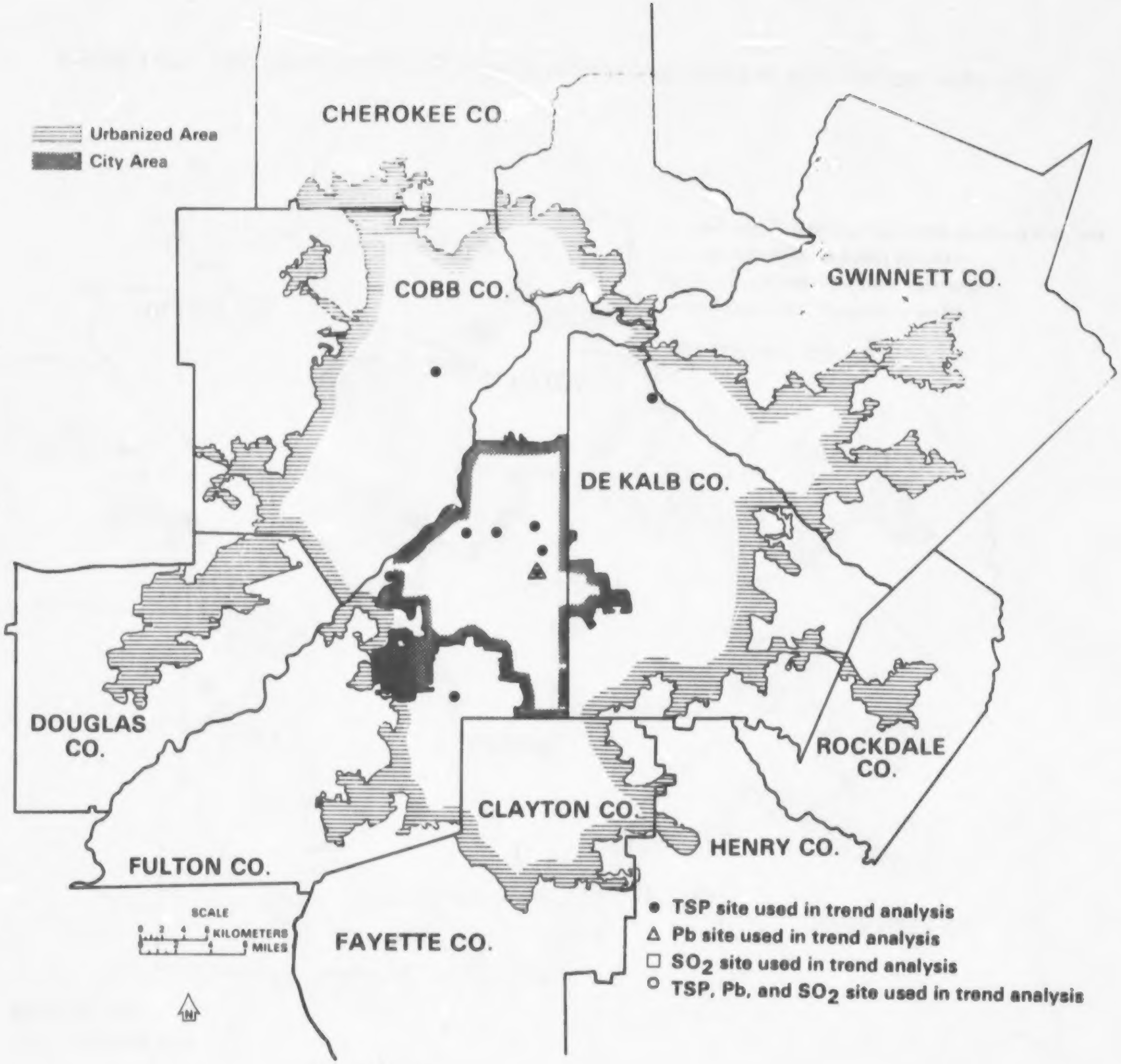

Urbanized Area
City Area
CHEROKEE CO.
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis

FIGURE 5-11. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN ATLANTA, GA, 1980-1983.

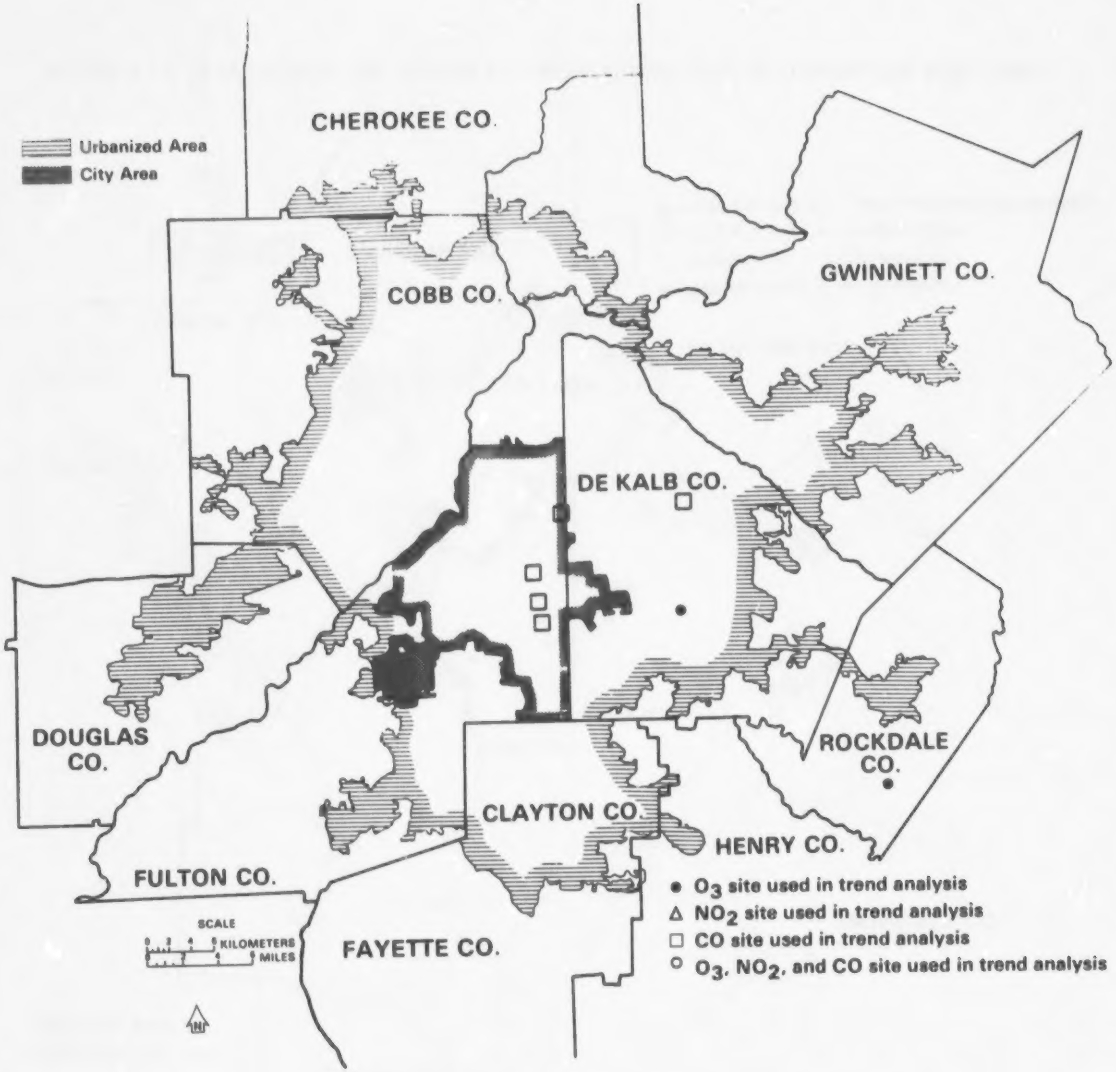

Urbanized Area
City Area
CHEROKEE CO.
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
KILOMETERS
MILES
N
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

FIGURE 5-12. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN ATLANTA, GA, 1980-1983.

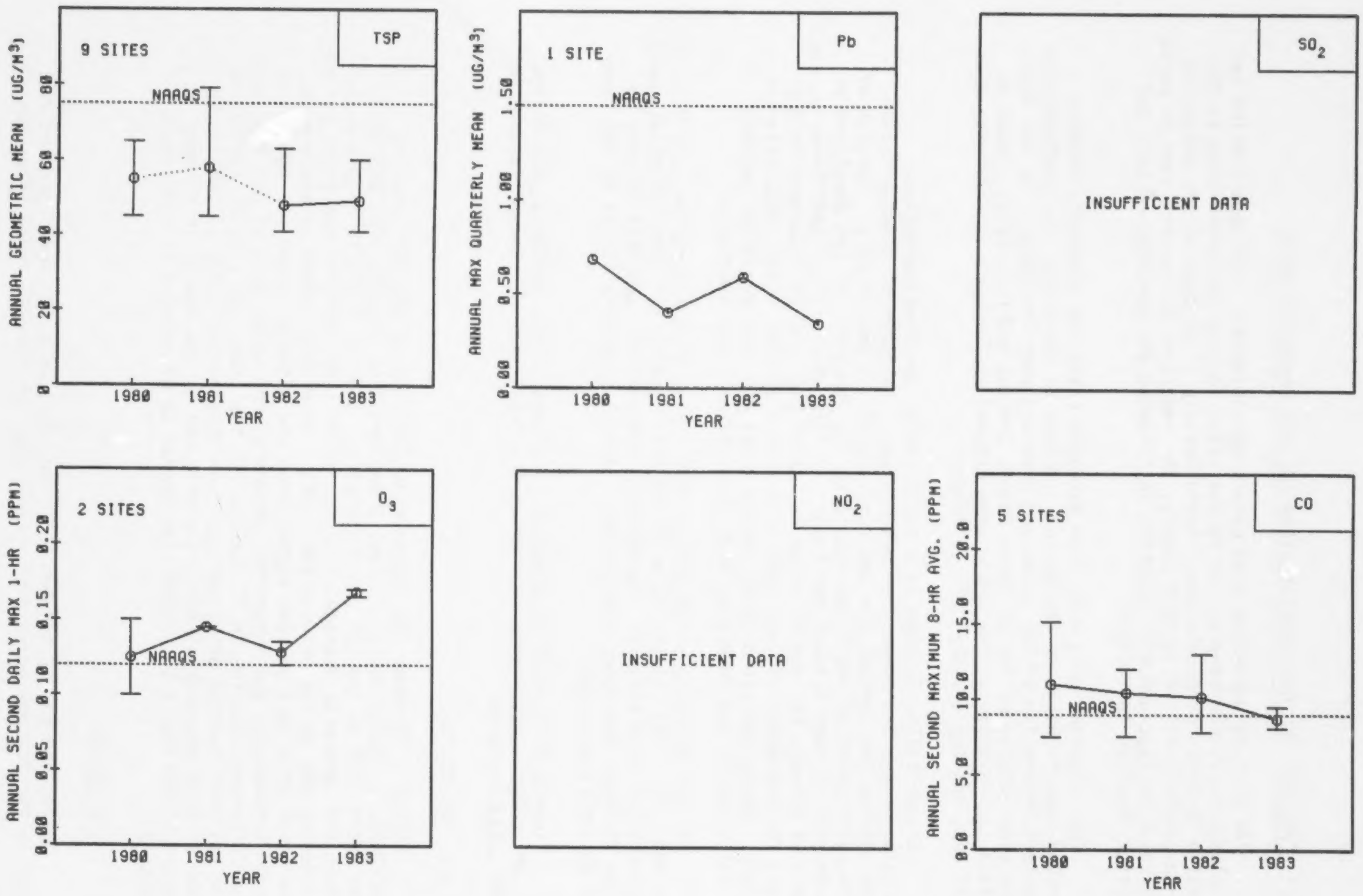


FIGURE 5-13. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE ATLANTA, GA URBANIZED AREA, 1980 - 1983.

5.5 CHICAGO, ILLINOIS-NORTHWESTERN INDIANA URBANIZED AREA

The Chicago urbanized area covers approximately 1300 square miles and includes 6,770,000 people. It is the third largest urbanized area in the nation in terms of population. Approximately 75 percent of the urbanized area population live in Cook County, the remaining 25 percent live in parts of Lake, Du Page and Will Counties in Illinois and portions of Lake and Porter Counties in Indiana.

The urbanized area runs from Waukegan (near the Wisconsin border) around Lake Michigan to Chesterton, Indiana to the east. The southern and western boundaries of the urbanized area are very irregular. To the south the area extends as far as Crown Point, Indiana and Park Forest South in Illinois. Similarly, the urban area extends as far west as Bartlett, West Chicago, and Napierville, all in Illinois.

Economically, Chicago is a major center for transportation, manufacturing, and commercial enterprises. In terms of transportation, Chicago has the largest air and rail traffic in the country. Because of Chicago's location and large manufacturing concerns, it has developed an extensive highway network for local and through traffic. Additionally, the port of Chicago on Lake Michigan has developed into an important inland port for raw materials and port of transfer for the Great Lakes-Atlantic trade. Among Chicago's chief manufactures are food products, primary metals (steel) and both elecrical and nonelectrical machinery.

Chicago occupies a relatively flat plains area bounded by Lake Michigan in the east. The climate is predominately continental with relatively warm summers and cold winters. Temperature extremes are somewhat altered by Lake Michigan and other Great Lakes. Annual precipitation is on the order of 33 inches per year.

Figures 5-14 and 5-15 show the locations of the monitors used in the trend analysis and Figure 5-16 shows the trends for all the pollutants in the urbanized area.

5.5.1 TSP Trends

Figure 5-14 shows the approximate location of the TSP sampling locations operated in the Chicago urbanized area between 1980 and 1983, that were used in the TSP trend analysis. The TSP trend in Figure 5-16 shows the composite average of 61 out of 97 sites meeting the trend criteria during the period between 1980-1983. Generally, these values are on the order of 3 to 5 percent higher than the national trend for NAMS sites, which considering the industrial nature of the urban area is not suprising. The 20 percent decline in TSP values for the urbanized area is similar to the national decline of 22 percent over this period (1980 to 1983). While some of this improvement must be attributed to the change in filters, discussed in Section 3.1.1, some also appear to be related to reductions in emissions.

5.5.2 Pb Trends

During the period between 1980 and 1983, 74 sites were operated for lead in the Chicago urban area. Lead data for many of these sites has not been submitted to EPA; therefore the Illinois State Annual reports for 1980-1983 have been used as a supplemental source for lead data to develop a Chicago area trend.[6-9] There were 43 sites shown on Figure 5-14 having at least 3 years of valid data during the period and used to compute the composite average of highest quarterly lead concentration. The Chicago trend for the period 1980 to 1983 is similar to the national trend for lead with the decline of 38 percent over the 4-year period, compared to 34 percent.

5.5.3 SO_2 Trends

Twenty-one SO_2 monitoring sites operated in the Chicago area of which 13 sites met the trend criteria with a minimum of 3 years of valid data. These sites are shown on Figure 5-14. The composite average of SO_2 values in Chicago has declined by approximately 21 percent between 1980 and 1983, which is 6 percent greater than the national decline of 15 percent. The higher rate of decline for Chicago may be related to the economic problems of heavy industry during this time period.

5.5.4 O_3 Trends

The O_3 trend for Chicago is based on the ten sites meeting the data completeness criteria out of the 28 sites operated during the period. The location of the trend sites is shown in Figure 5-15. The composite average of second daily maximum hour concentrations for Chicago shows patterns very similar to the national trend in that the composite averages decline each year between 1980 and 1982 with a pronounced 33 percent increase occurring between 1982 and 1983 (Figure 5-16). As noted in Section 3.5.1, a meteorological index was developed for Chicago, which suggests that the 1982-83 increase in O_3 levels is partly attributable to meteorology.[10]

5.5.5 NO_2 Trends

During the period 1980 to 1983 there were 56 NO_2 monitoring sites operated in the urban area, 17 of which were used for the Chicago NO_2 trend. The location of these 17 sites is shown in Figure 5-15. Eight of the 56 sites utilized continuous monitors and the remaining 48 sites used bubblers. The composite annual average concentrations for the Chicago area are similar to the national trend for all sites. The composite average declined 20 percent for Chicago over the 4-year period, as compared to 12 percent for the nation. There is no apparent reason for the comparatively larger decline in the Chicago area.

5.5.6 CO Trends

The CO trends are based on 4 of the 13 sites operated during the period which met the data completeness criteria. The location of these sites is shown on Figure 5-15. During the time period, the CO composite averages declined by nearly 17 percent from 1980 through 1982 and then increased in 1983 for a net change of 4 percent. The increase for 1983 appears to be related to a severe air stagnation episode occurring on February 28 and March 1, 1983.[11]

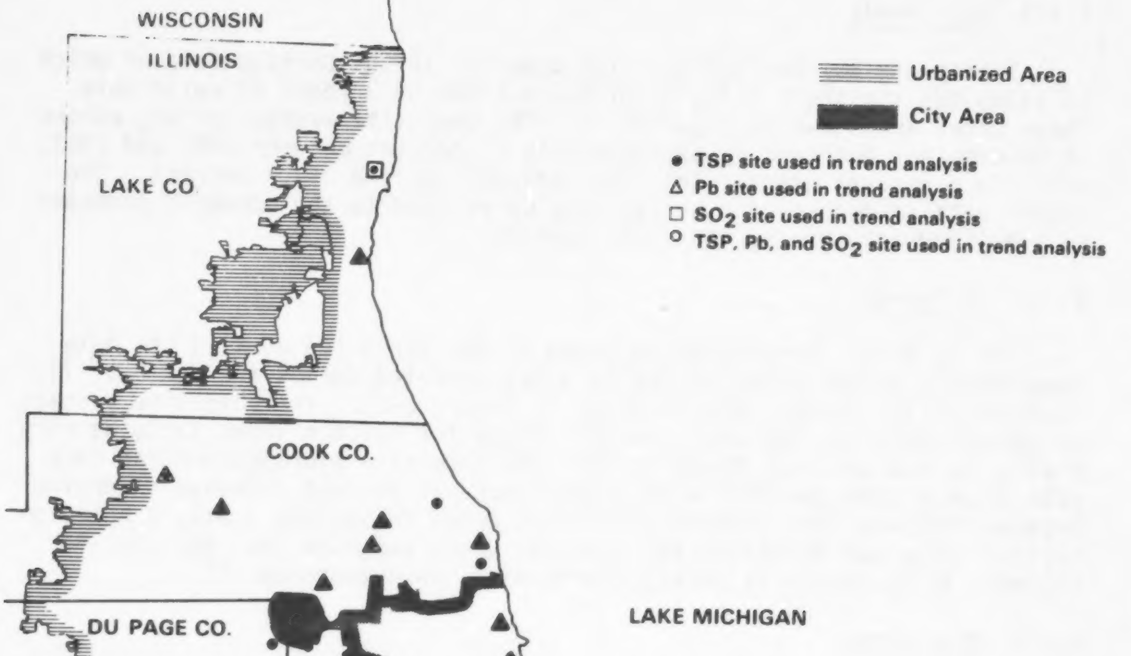

WISCONSIN
ILLINOIS
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
LAKE CO
COOK CO.
DU PAGE CO.
LAKE MICHIGAN
WILL CO
LAKE CO
PORTER CO
KILOMETERS
MILES
ILLINOIS INDIANA

FIGURE 5-14. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN CHICAGO, IL-IN, 1980-1983.

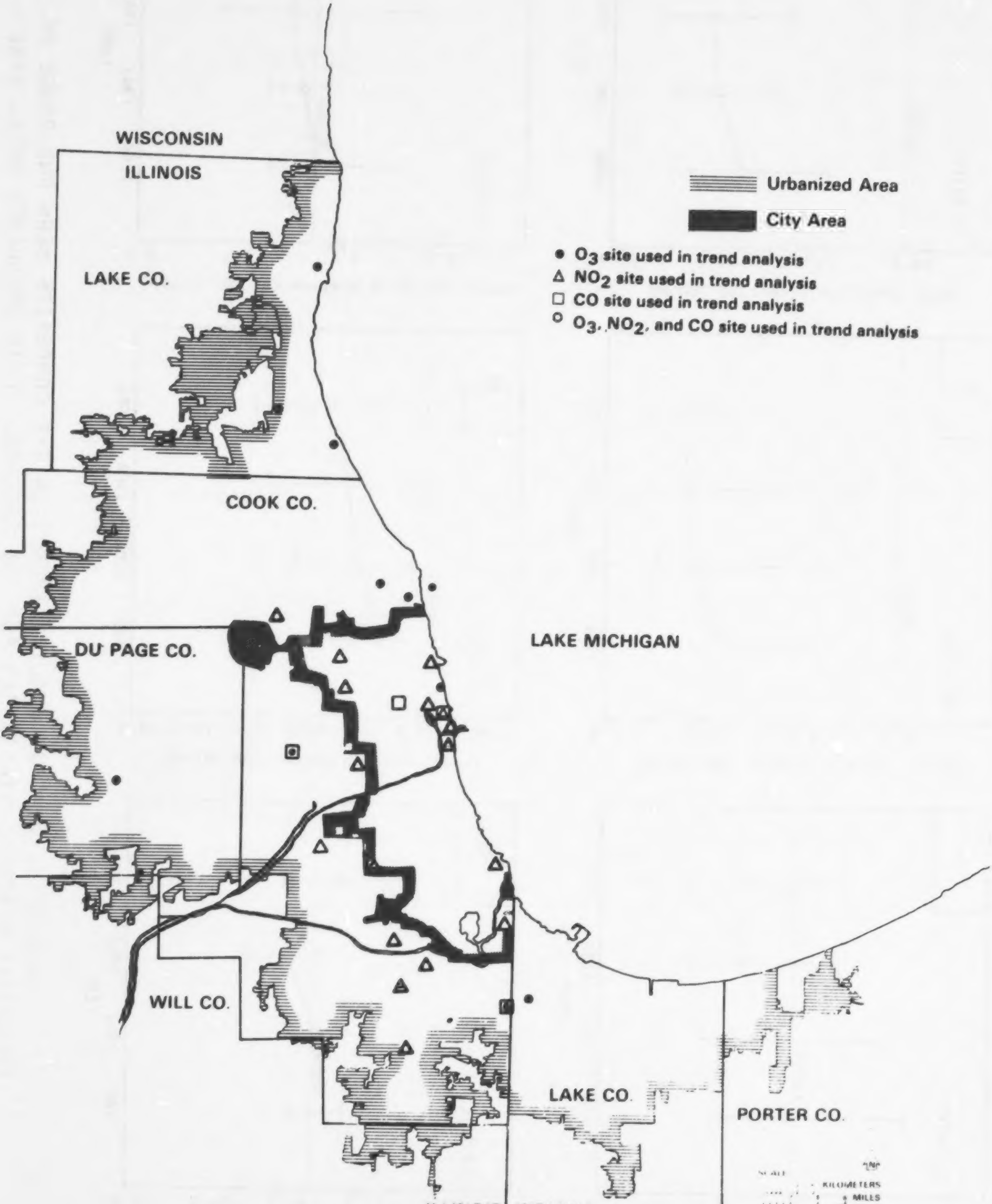

WISCONSIN
ILLINOIS
Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
LAKE CO.
COOK CO.
DU PAGE CO.
LAKE MICHIGAN
WILL CO.
LAKE CO.
PORTER CO.
KILOMETERS
MILES
ILLINOIS
INDIANA

FIGURE 5-15. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN CHICAGO, IL-IN, 1980-1983.

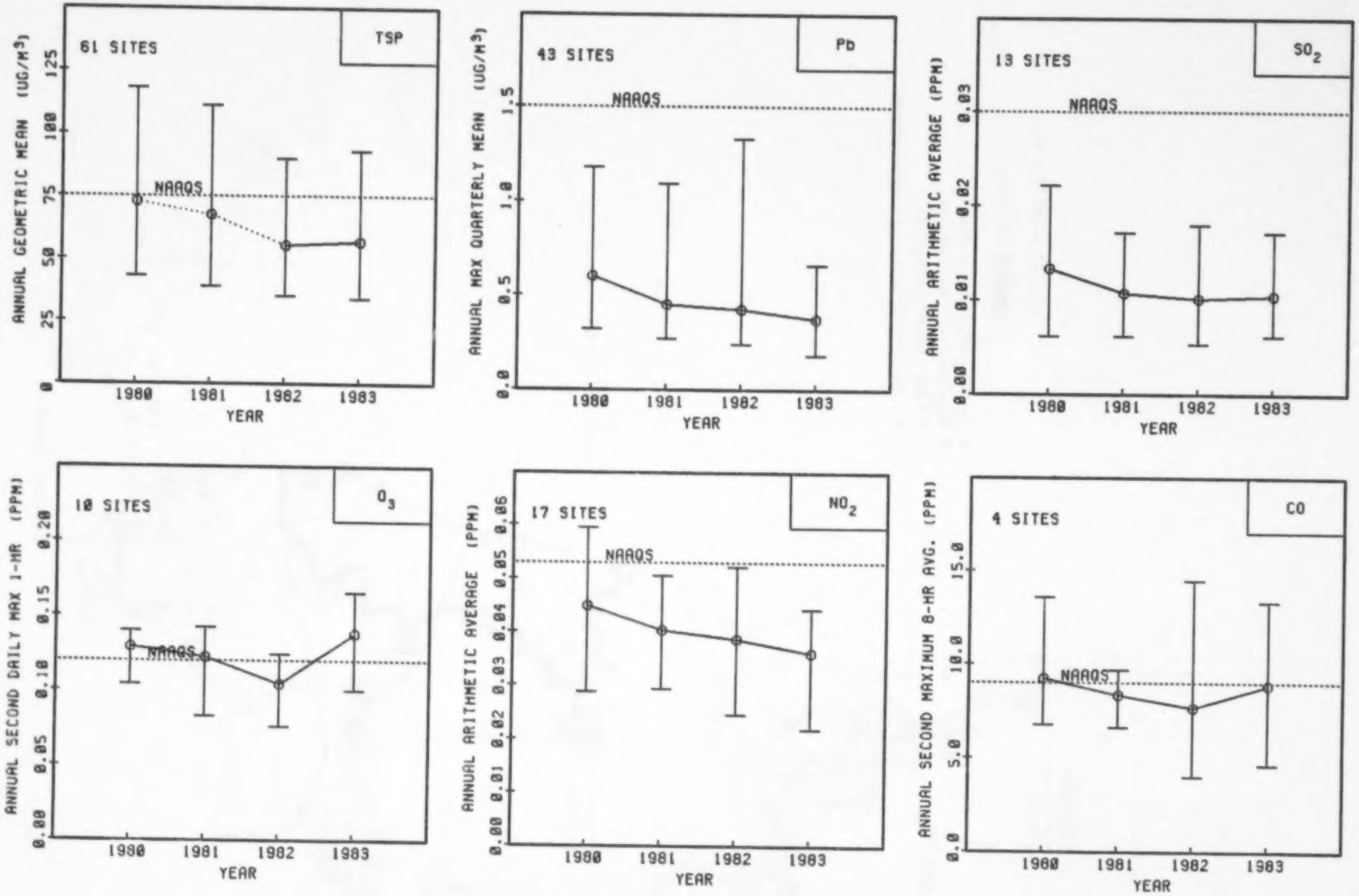


FIGURE 5-16. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE CHICAGO, IL-IN URBANIZED AREA, 1980 - 1983.

5.6 HOUSTON, TEXAS URBANIZED AREA

The Houston urbanized area is the tenth largest in the United States with a population of 2,412,664. It includes almost all of Harris County and very small portions of six other counties. The urbanized area extends about 55 miles east to west and 45 miles north to south and covers a total of approximately 750 square miles. The City of Houston has a population of 1,595,138 and is located west of Galveston Bay about 50 miles inland from the Gulf of Mexico.

Houston is a major seaport, particularly for petroleum products and has many refinery and petrochemical complexes along the Houston Ship Channel, which runs approximately 20 miles from the Houston center city east to Galveston Bay. The area is in the Sunbelt, has a mild climate moderated by the Gulf of Mexico, and is one of the fastest growing of all the major urbanized areas. The population has increased 44 percent since 1970.

Figure 5-17 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-18 shows the location of the O_3, NO_2, and CO sites used in the trend analysis. Figure 5-19 shows the trends of the six pollutants during the study period.

5.6.1 TSP Trends

The Houston TSP trend was developed from 36 sites which met the data completeness criteria out of the 47 sites which operated during the period. Figure 5-17 shows the geographic distribution of the 36 sites which were used in the TSP trend analysis. The TSP trend in Houston is similar to the national trend with the first 2 years substantially higher than the last 2 years. The decrease is thought to be significantly affected by a change in filters (see Section 3.1.1), and the 23 percent drop from the first to the last year is nearly identical with the 22 percent decrease found on a national basis.

5.6.2 Pb Trends

The Pb trend in Houston shows a 36 percent decrease compared to a 34 percent drop nationally for the 1980-1983 period. This trend is based on 25 sites which met the data completeness criteria. The data for 7 of these 25 sites were obtained from the EPA's National Aerometric Data Bank (NADB), and data for the remaining sites were from the Houston Health Department.[12]

5.6.3 SO_2 Trends

The Houston SO_2 trend is based on 5 out of 13 sites which operated during the study period. SO_2 concentrations decreased 10 percent between 1980 and 1983, which is comparable to the 15 percent decrease in the national trend for the same time period.

5.6.4 O_3 Trends

The pattern of the O_3 concentration in the Houston area is identical with the national average, 1980 and 1983 are high, while 1981 and 1982 are lower. Similar to the national trend, meteorology may have been more favorable for ozone buildup in 1983 than in 1981 and 1982. Nationally, between 1980 and 1983, there is no change in O_3 levels between the two years. In contrast, 10 of 15 monitoring sites in Houston, meeting the data completeness criteria, show a 5 percent decrease between 1980 and 1983 and a 25 percent increase from 1982 and 1983.

5.6.5 NO_2 Trends

The Houston downward trend for NO_2 is three times greater than the national average, a 36 percent reduction versus a 12 percent reduction. This trend is based on four sites out of a total of 39 sites which monitored NO_2 in the Houston area during the 1980-1983 study period and met the data completeness criteria. These monitors are for the most part in backgound locations and have a relatively low annual average. Monitors located in higher NO_2 emission areas do not have a long enough data history to be used in the trend analysis at this time, although they are reading two to three times higher than the composite average of the sites used in the trend analysis.

5.6.6 CO Trends

The Houston CO trend shows an 8 percent increase in contrast to the 11 percent drop in the national average. This increase is probably reflective of an increase in automobile traffic volume in the vicinity of the trend sites. This trend is based on only three of the nine CO monitoring locations which operated during the study period and had enough data to meet the data completeness criteria.

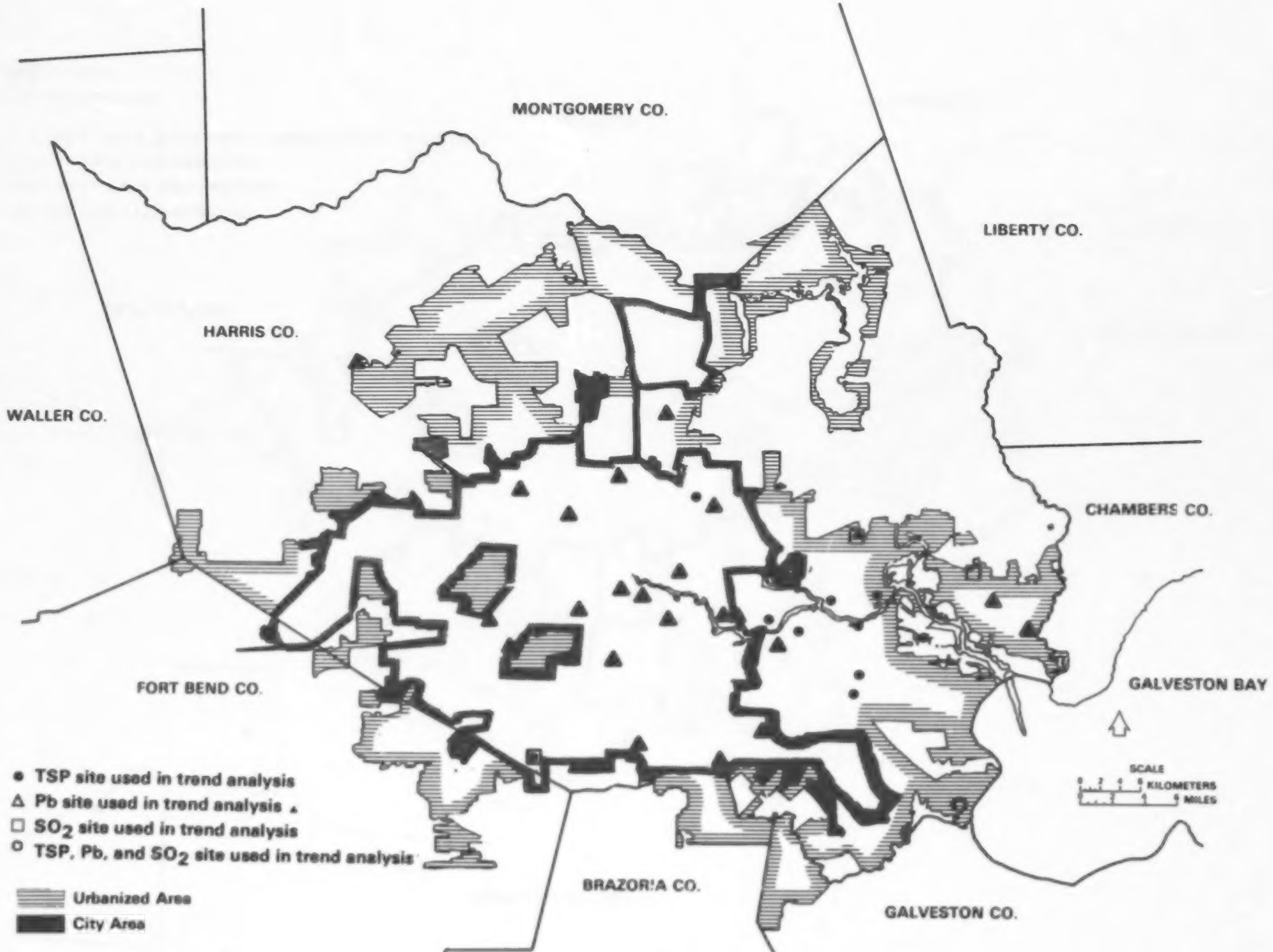

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO.
GALVESTON BAY
FORT BEND CO.
BRAZOR!A CO.
GALVESTON CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
Urbanized Area
City Area

FIGURE 5-17. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN HOUSTON, TX, 1980-1983.

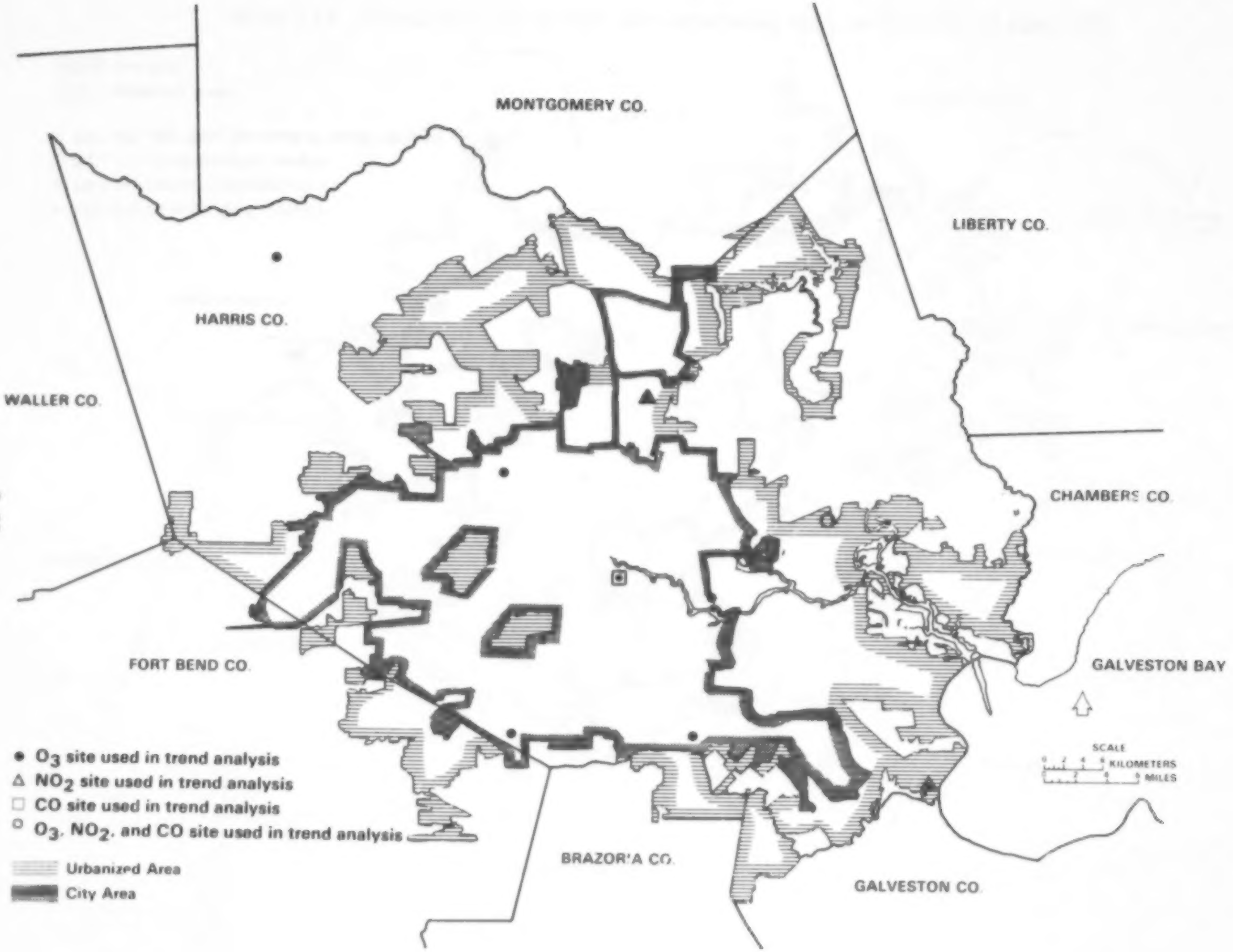

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO.
FORT BEND CO.
GALVESTON BAY
BRAZORIA CO.
GALVESTON CO.
SCALE
0 2 4 6 KILOMETERS
0 2 MILES
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
Urbanized Area
City Area

FIGURE 5-18. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN HOUSTON, TX, 1980-1983.

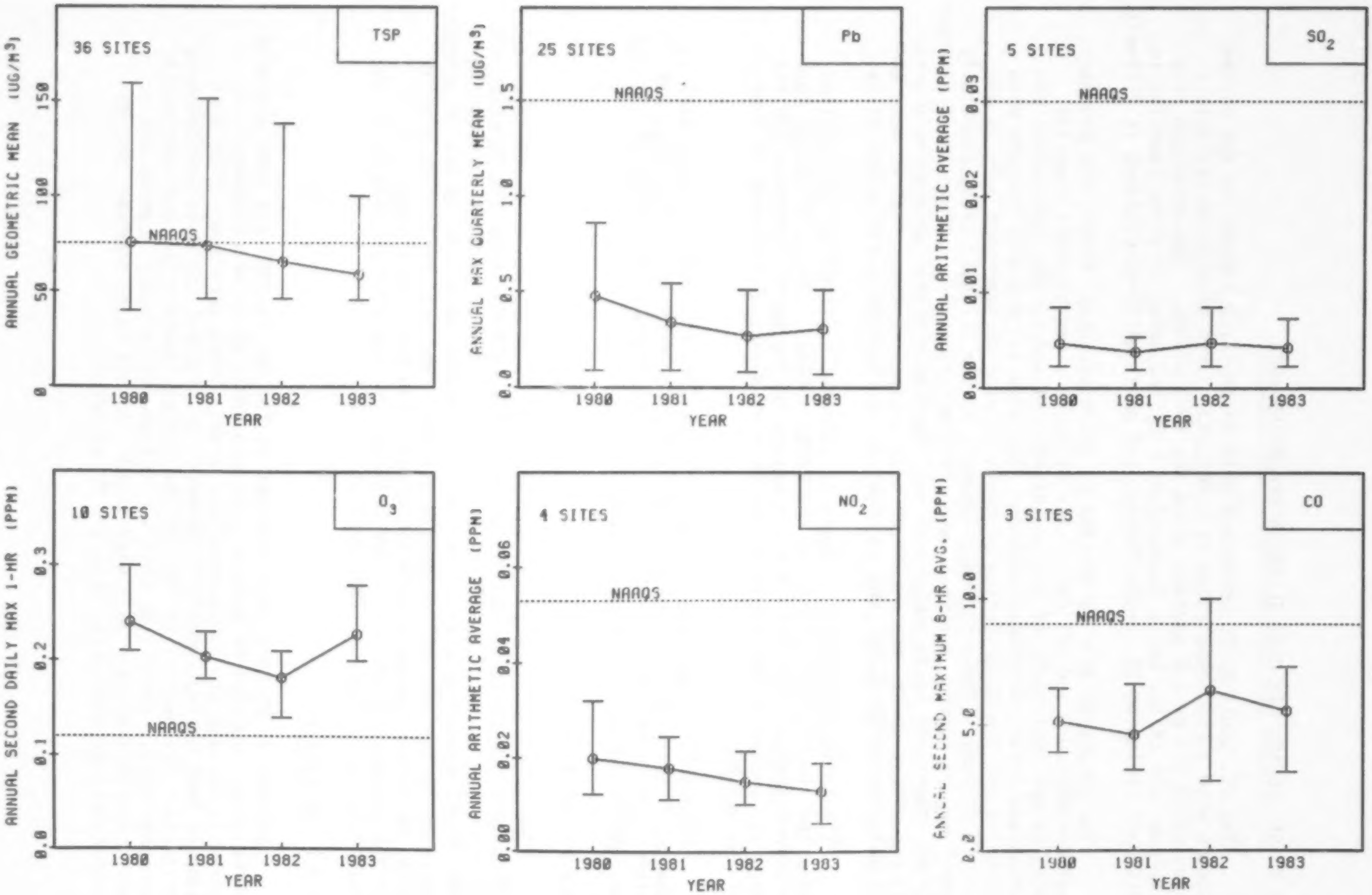


FIGURE 5-19. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE HOUSTON, TX URBANIZED AREA, 1980 - 1983.

5.7 ST. LOUIS, MISSOURI-ILLINOIS URBANIZED AREA

The St. Louis MO/IL urbanized area is the 11th largest in the United States with a 1980 population of 1,848,590. This population reflects a loss of 33,354 or 1.8 percent since the 1970 census. The urbanized area includes all of St. Louis Independent city and parts of three counties in Missouri including St. Louis County, and parts of three counties in Illinois.

The urbanized area is divided by the Mississippi River, the boundary between Missouri and Illinois. The Missouri River branches from the Mississippi just north of the urbanized area and further subdivides the urbanized area's northwest section. The area is centrally located with commerce and the distribution of goods playing an important part in the area's economy. There is heavy industry on the Illinois side, especially steel manufacturing, smelting, and chemical processing. Along the Mississippi River, there are large numbers of fuel burning electric generating plants. At its widest point, the urbanized area extends 48 miles east to west and 32 miles north to south, and encompasses approximately 509 square miles.

The areas continental climate is somewhat modified by its location near the geographical center of the United States. The area enjoys four distinct seasons with the cold air masses to the North in Canada and the warm air masses to the South in the Gulf of Mexico alternating in control of the weather.

Figure 5-20 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-21 shows the location of the O_3, NO_2, and CO sites used in the trend anslysis. Figure 5-22 shows the trends of the six pollutants during the study period.

5.7.1 TSP Trends

The trend in St. Louis is derived from 24 sites out of a possible 33 which were operating during the period. Figure 5-20 shows the location of the 24 sites used in the TSP trend analyses. The 25 percent decrease in the annual geometric mean in St. Louis is nearly identical to the 22 percent decrease in the national composite average. The pattern is also similar with the first 2 years distinctly higher than the last 2 years. A change in the composition of the filter between 1981 and 1982 is felt to be the reason for this decrease (see Section 3.1.1).

5.7.2 Pb Trends

Because no Pb data were reported to the EPA in 1980 and 1981 and only three sites reported Pb data in 1982 and 1983, no Pb trend analysis is possible for the St. Louis urbanized area. There were four sites that sampled lead during 1980-1983; however, no site met the data completeness criteria. The general trends for the mobile source sites show decreasing concentrations, and a site that was influenced by mobil sources and a point source indicated an upward trend. In all cases however, the Pb concentrations were well below the Pb standard.

5.7.3 SO_2 Trends

The trend in annual average SO_2 in St. Louis shows a 12 percent increase over the period 1980-1983, while the national composite average has dropped 15 percent during the same period. The increase in St. Louis is believed to be attributable to a general economic recovery in the area. The trend in St. Louis is based on 8 out of a possible 19 sites operating during 1980-1983.

5.7.4 O_3 Trends

The St. Louis O_3 trend is based on 11 of 23 sites which operated during the 1980-1983 period. These sites showed a 2 percent increase between 1980 and 1983 and a 32 percent increase between 1982 and 1983. The pattern over the 4-year period is similar to the national trends, that is, high levels in 1980 and 1983 and lower levels in 1981 and 1982. As with many sections of the rest of the country, meteorological conditions may have been more favorable for ozone formation in 1983 than in 1981 and 1982.

5.7.5 NO_2 Trends

The 13 percent decrease in the NO_2 trend is similar to the 12 percent decrease on a national basis even though only 4 out of 17 possible site locations met the data completeness criteria required for inclusion in the trend analysis.

5.7.6 CO Trends

The trend in the St. Louis urbanized area is based on 5 of 15 sites which had sufficient data to meet the criteria for trend analysis. The 6 percent decrease in the CO trend is comparable with the national 11 percent decrease during the study period. This smaller decrease could be attributed to the general economic recovery of the area even though there was a small population loss in the urbanized area over the previous 10 years.

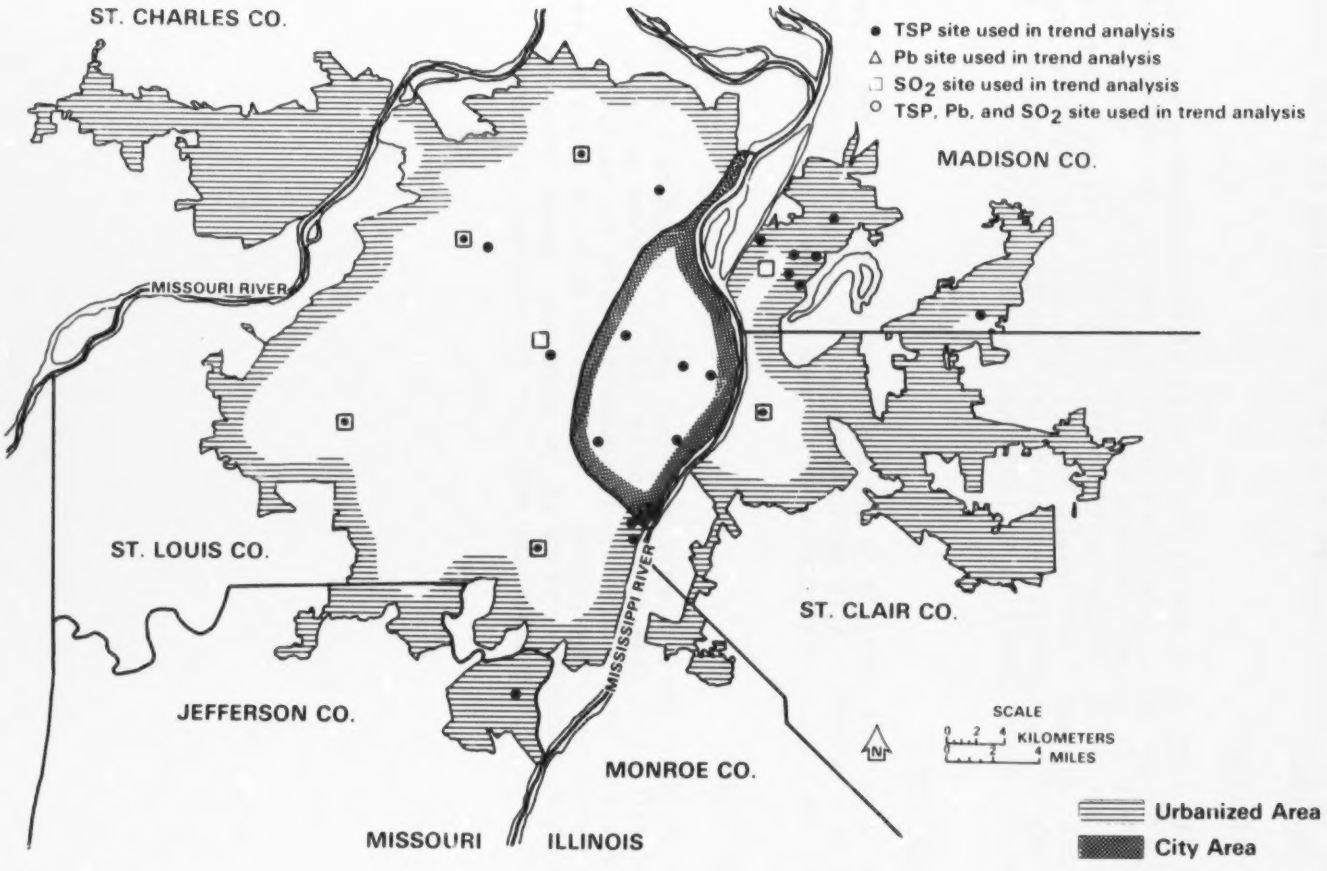

ST. CHARLES CO.
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
ST. CLAIR CO.
MISSISSIPPI RIVER
JEFFERSON CO.
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
MONROE CO.
MISSOURI
ILLINOIS
▤ Urbanized Area
▩ City Area

FIGURE 5-20. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN ST. LOUIS, MO-IL, 1980-1983.

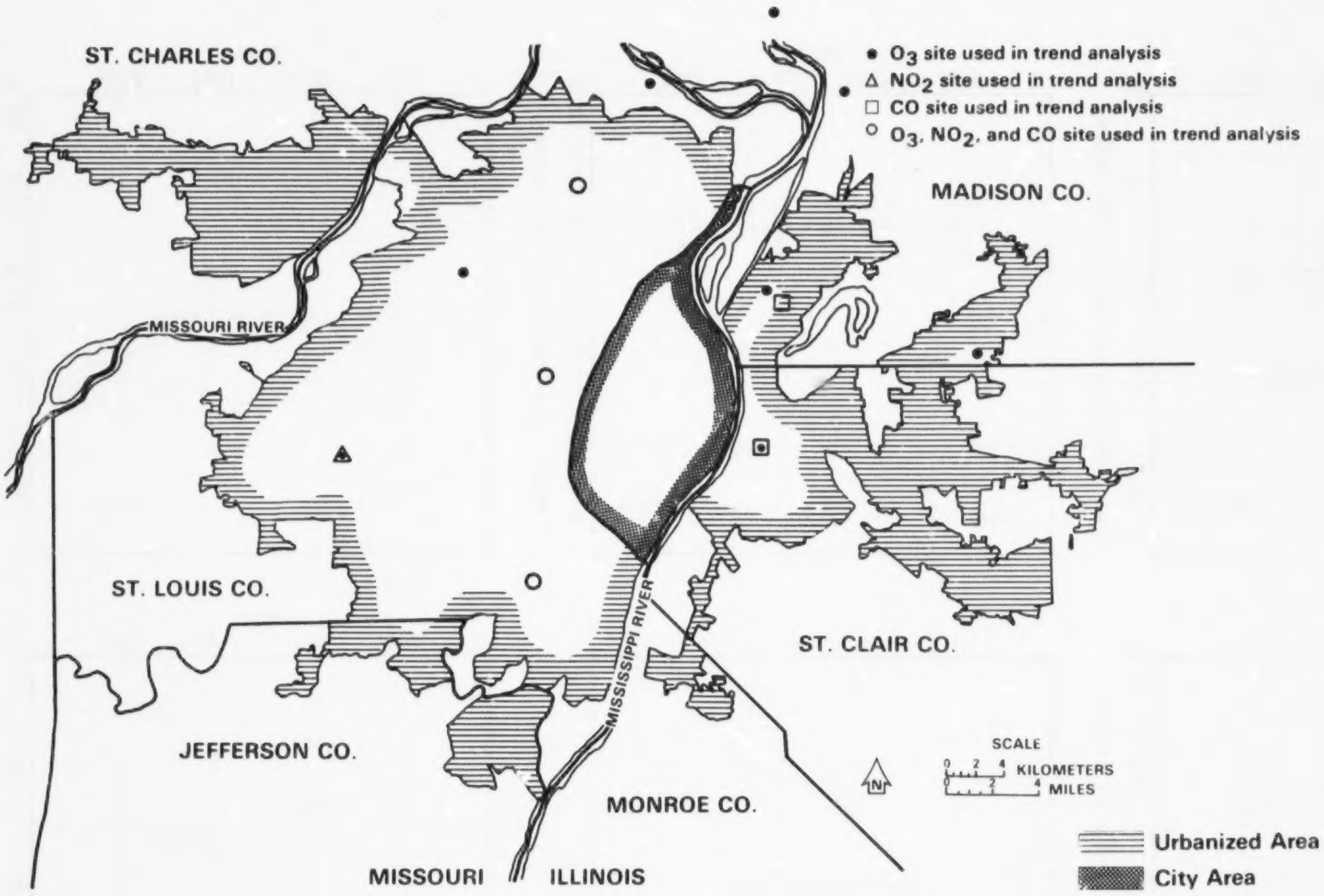

ST. CHARLES CO.
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
ST. CLAIR CO.
MISSISSIPPI RIVER
JEFFERSON CO.
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
MONROE CO.
MISSOURI
ILLINOIS
Urbanized Area
City Area

FIGURE 5-21. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN ST. LOUIS, MO-IL, 1980-1983.

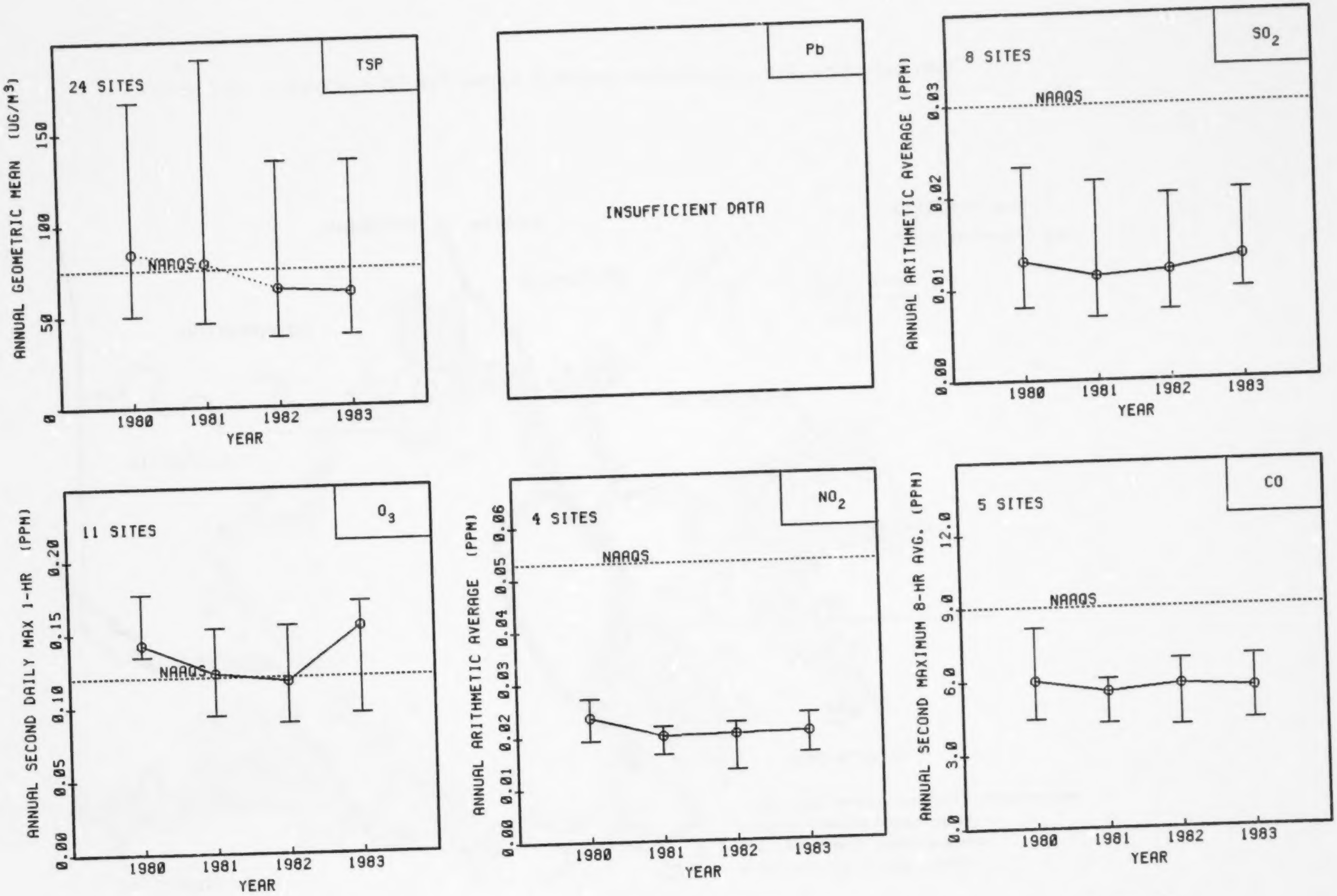


FIGURE 5-22. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE ST. LOUIS, MO-IL URBANIZED AREA, 1980 - 1983.

5.8 DENVER, COLORADO URBANIZED AREA

The Denver urbanized area had a 1980 population of 1,352,070 and includes all of Denver County plus portions of Adams, Arapahoe, Boulder, Douglas, and Jefferson Counties. At the maximum boundaries, the urbanized area extends about 27 miles east to west and 26 miles north to south.

Denver, the capital of Colorado, is located at the western edge of the great plains of the Midwest. The Rocky Mountains are just to the west of the urbanized area. Denver is one of the highest cities in the United States with an altitude of about 1 mile above sea level.

Although manufacturing is minimal compared to other cities of similar populations, Denver does have manufacturing industries for rubber goods and luggage. Other industries include food processing, milling, printing and publishing, steel processing, machinery manufacture, and power generation. Denver has a large stockyard and has the largest sheep market in the United States. In recent years, many energy concerns have located their headquarters in Denver.

The meteorology in Denver is unique in that air masses from at least four different sources influence the weather in the urbanized area. These sources are polar air from Canada and the far northwest, moist air from the Gulf of Mexico, warm dry air from Mexico and the southwest, and Pacific air modified by the passage overland. Since Denver is a long distance from any moisture source and is separated from the Pacific source by high mountains, Denver generally has low relative humidity and low average precipitation of around 14 inches per year.

Figure 5-23 and 5-24 show the locations of the monitors used in the trend analysis, and Figure 5-25 show the trend graphs for the pollutants.

5.8.1 TSP Trends

Fourteen sites sampled TSP in the urbanized area during 1980-1983 and 12 of these sites met the data completeness criteria and were used in the trend analysis. Figure 5-16 shows the location of the 12 samplers used for the trend. Figure 5-17 shows a plot of the trends for 1980-1983 in which the composite average decreased 23 percent compared to the national decrease of 22 percent for the same period. Some of the decrease between 1981 and 1982 has been attributed to the filters used for collecting the samples (see Section 3.1.1). The TSP composite average was above the NAAQS for each year during 1980-1983. The elevated TSP levels in Denver have been attributed to the arid conditions and reentrainment of dust particles.

5.8.2 Pb Trends

There were ten sites in the urbanized area which sampled Pb during 1980-1983 and four sites met the data completeness criteria. The Pb data for 1983 were taken from the Colorado annual data report.[13] The trend from 1980 to 1983 in Denver decreased 34 percent or the same as the national decline of 34 percent. The composite average of the four sites in Denver is about twice as high as the national composite. This, like TSP measurements, are believed to be caused in part by low rainfall conditions cited previously resulting in more reentrainment of Pb particles in street dust.

5.8.3 SO_2 Trends

The SO_2 trends for the urbanized area were developed from two sites out of the three sites which had data during 1980-1983. The trends for the composite average show minor fluctuations with essentially no change during the period. The composite averages are about one-third of the NAAQS.

5.8.4 O_3 Trends

Six sites out of seven sites met completeness criteria and were used in the trend analysis. The composite average for the six sites increased each year during 1980-1983 with the 1983 levels 16 percent higher than the 1980 level and 8 percent higher than the 1982 level. There are no readily apparent reasons for the increases. The national composite trend showed no change for the same period.

5.8.5 NO_2 Trends

There were three sites that reported NO_2 data during 1980-1983, and all three sites were used in the trend analysis. The composite average decreased slightly from 1980-1982, and then increased in 1983. The overall increase from 1980-1983 was 9 percent as compared to the national decline of 12 percent. The concentrations measured at a site in downtown Denver continue to be among the highest in the nation due to mobile and point sources.

5.8.6 CO Trends

The CO concentrations were measured at ten sites in the urbanized area and six of these sites met the data completeness criteria and were used for the trend analysis. The composite average shows 20 to 25 percent fluctuations from year to year with 1983 reporting the same level as 1980. The use of wood for home heating in air tight stoves in recent years could contribute up to 10 percent of the measured CO concentrations.[13] The national composite average decreased 11 percent for the same period. The composite average for each year was above the NAAQS.

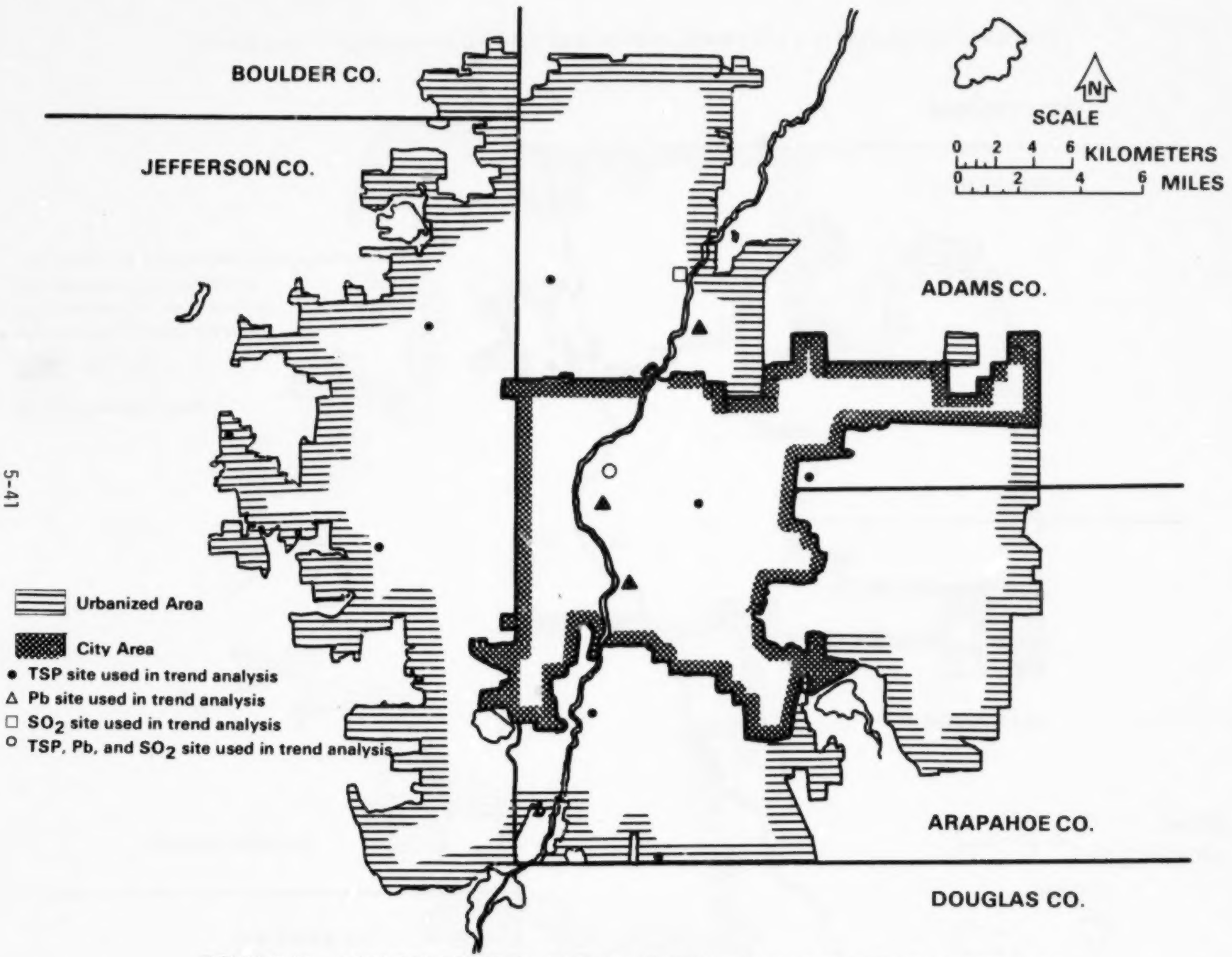

BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
DOUGLAS CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis

FIGURE 5-23. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN DENVER CO, 1980-1983.

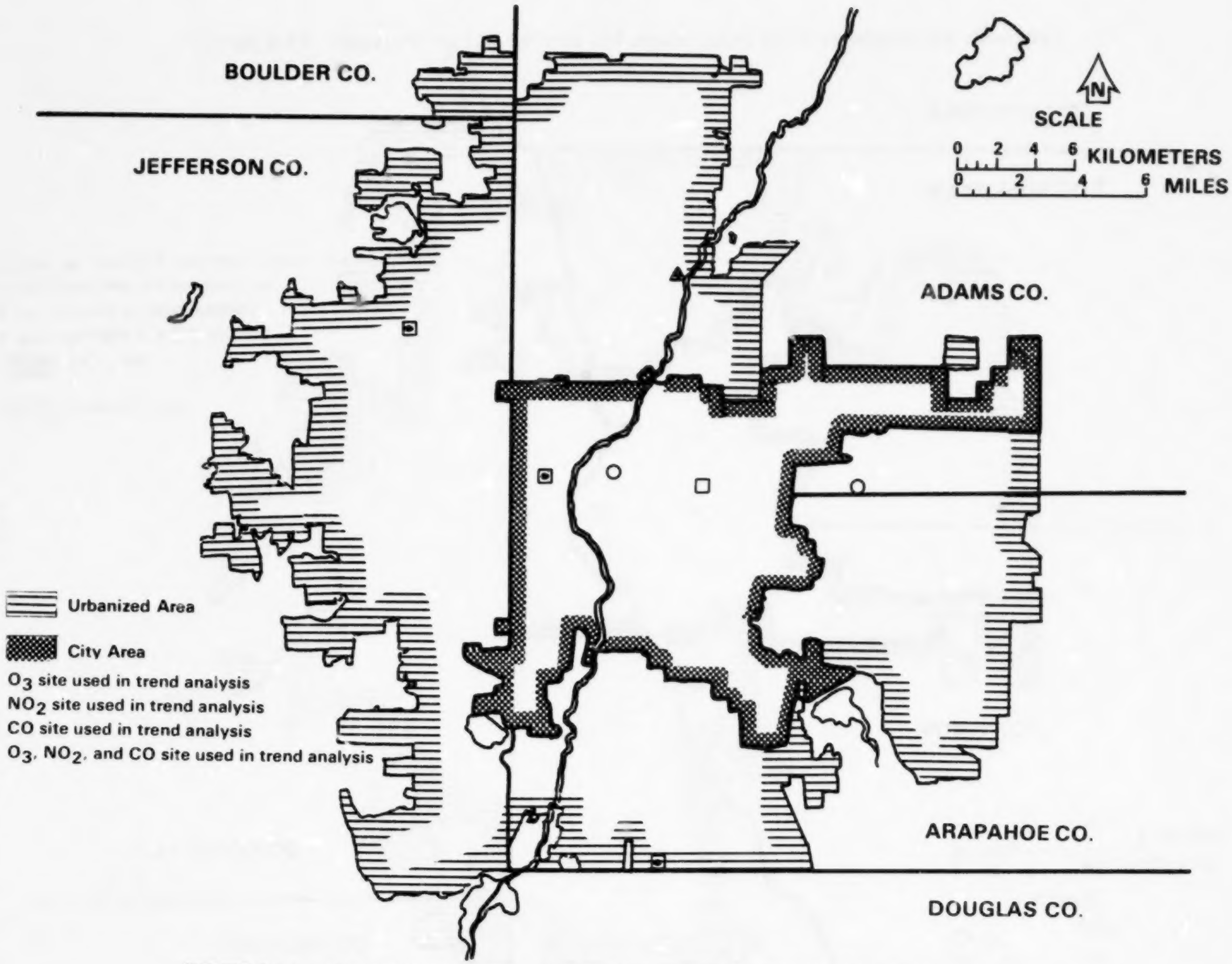

BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
DOUGLAS CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

FIGURE 5-24. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN DENVER, CO, 1980-1983.

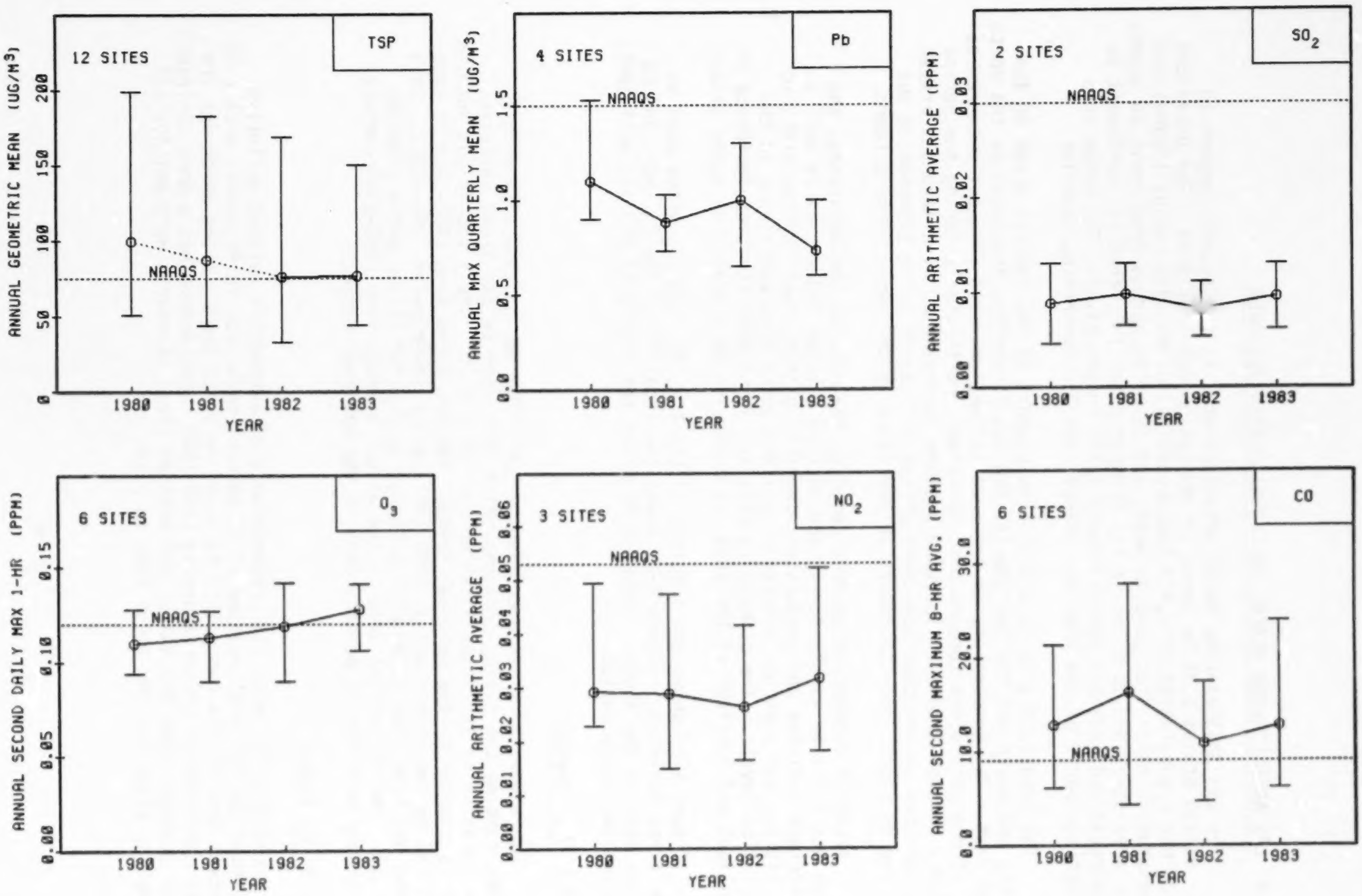


FIGURE 5-25. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE DENVER, CO URBANIZED AREA, 1980 - 1983.

5.9 LOS ANGELES-LONG BEACH, CALIFORNIA URBANIZED AREA

The Los Angeles-Long Beach urbanized area is the second largest in the United States both in terms of population and land area. The urbanized area has a population of 9,479,436 according to the 1980 census figures and measures 70 miles from east to west, and 71 miles across from north to south. The area stretches 90 miles in its longest dimension, that is, northwest to southeast and contains approximately 1,700 square miles. The urban area comprises parts of Los Angeles, Orange, and San Bernardino Counties.

The urbanized area is a flat area bounded by the Pacific Ocean on the west, and south and the San Gabriel and San Bernardino Mountains on the north and east. The meteorology in the area is complex, with frequent occurrences of strong persistent temperature inversions, particularly during the period of May through October. The wind pattern is dominated by a land-sea breeze circulation system that sometimes allows pollutants to be transported out to sea at night, only to return inland later in the early morning hours.

Although automotive sources comprise the bulk of the emissions, the area has a lot of manufacturing and service related industries as well as petroleum refining and production, chemical plants, fuel burning electric utilities, and numerous industrial boilers which also contribute to the pollution levels. The climate is mild and along with the high incidence of sunlight and latitude of the area, is conducive to a year-long ozone season.

Figure 5-26 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-27 shows the location of the O_3, NO_2, and CO sites used in the study. Figure 5-28 shows the trends of the six pollutants during the study period.

5.9.1 TSP Trends

There were 22 sites operating at some time during 1980-1983 with 12 sites meeting the siting criteria which were used in the trend analysis. The location of the sites is shown in Figure 5-26. The trend in Los Angeles TSP is similar to the national trend. The TSP trend from 1980-1983 is exemplified by two higher years, 1980-1981, and 2 lower years, 1982-1983. This trend has been associated with a change in the TSP filter media (Section 3.1.1). The 20 percent drop in the annual average from 1980-1983 compares favorably with the 22 percent drop in the national trend.

5.9.2 Pb Trends

Los Angeles, with its preponderance of automotive related pollution, exceeded the national average of 34 percent reduction in Pb levels with a 52 percent drop of its own. This is based on 13 of the 21 sites which met the data completeness criteria during 1980-1983. California has a more stringent lead standard than the NAAQS, and both of these standards were met for all sampling sites for the first time in 1983.

5.9.3 SO_2 Trends

The drop in Los Angeles of 37 percent in annual average SO_2 levels is over two times the 15 percent decline seen nationally. This trend is made up of 15 monitors which met data completeness criteria of the 24 monitors which operated during the period. The increased improvement is attributed to having cleaner fuels and a major point source, a steel facility, shutting down during the period.

5.9.4 O_3 Trends

The O_3 trend in Los Angeles closely parallels the national trend with an average drop of 1 percent over the 4-year period. Between 1982 and 1983, the O_3 levels increased 15 percent. On a national basis, the years 1980 and 1983 may have been meteorologically favorable for producing O_3 levels, and this is also the pattern shown for Los Angeles. The trend is based on 20 of 26 sites which operated during this period. A recent trend analysis conducted by the South Coast Air Quality Management District indicates that 1982 was a year of record low meteorological ozone forming potential, and that 1983 was a return to near normal meteorological conditions.[10]

5.9.5 NO_2 Trends

Of the 22 sites operating in the Los Angeles area, 16 met the trends criteria and were used in the analysis. The Los Angeles NO_2 levels decreased 8 percent, compared with a 12 percent reduction for the nation.

5.9.6 CO Trends

The decrease in the CO levels is about two times the national average, that is, 23 percent versus 11 percent. This trend is comprised of 16 of the 22 sites operating during the 1980-1983 period. The percentage reduction is thought to be greater than the national average because of the commensurate severity of automotive related pollution in Los Angeles relative to the rest of the nation, and the stringency of their automotive control program. Also, the average meteorology for 1980-1983 has been slightly less favorably to the buildup of CO.[14]

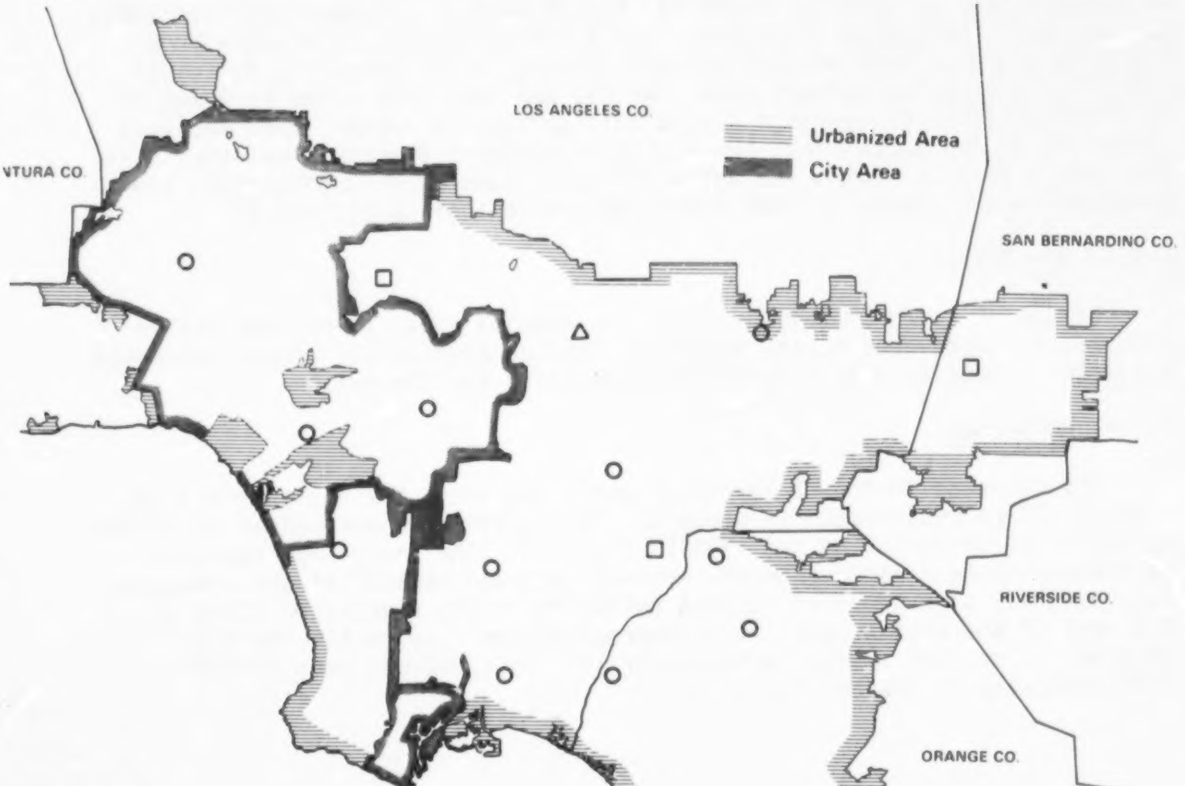

LOS ANGELES CO.
Urbanized Area
City Area
NTURA CO.
SAN BERNARDINO CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC OCEAN
SAN DIEGO CO.
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
SCALE
KILOMETERS
MILES

FIGURE 5-26. LOCATION OF TSP, Pb, AND SO$_2$ MONITORING SITES IN LOS ANGELES, CA, 1980-1983.

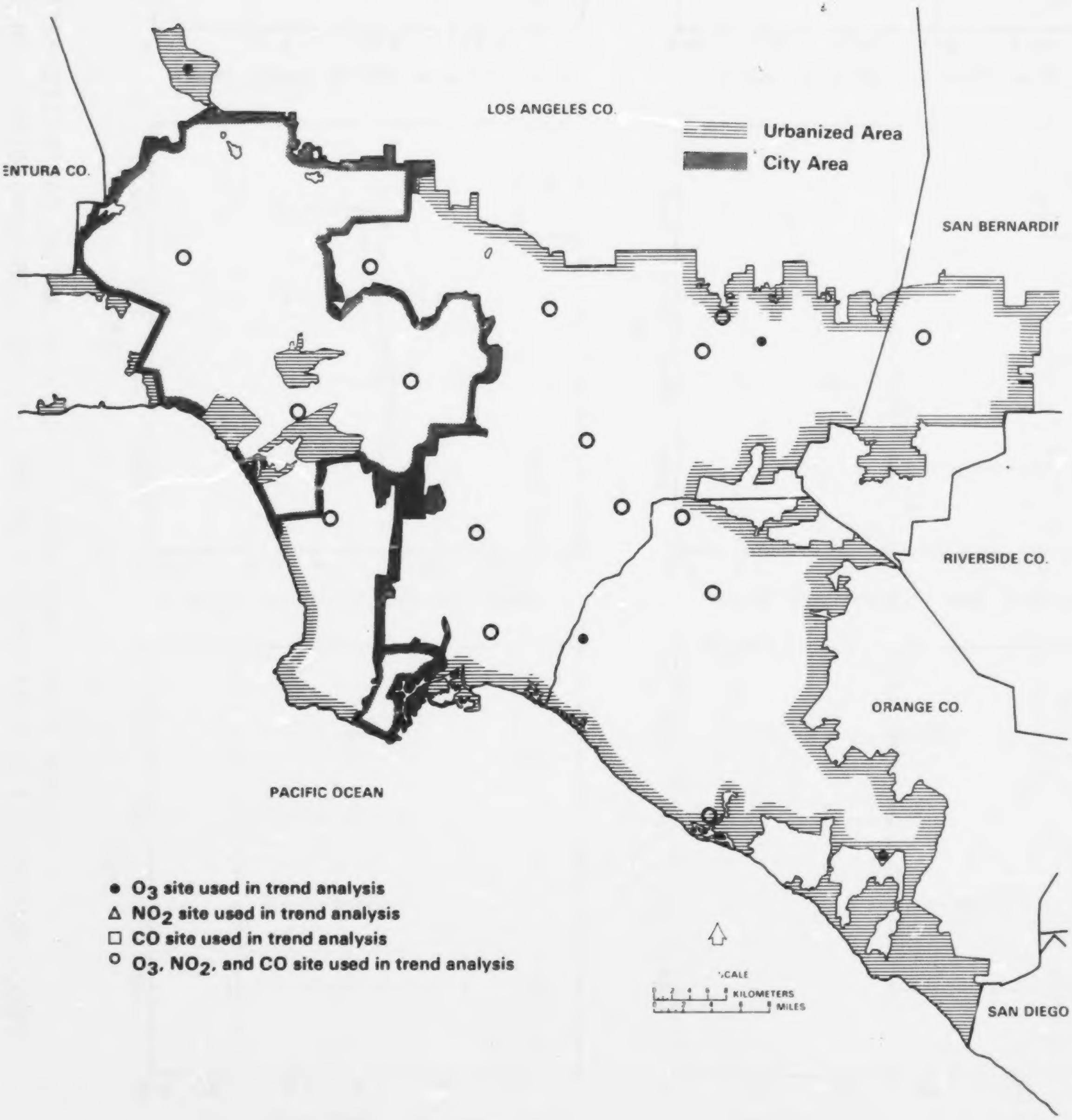

LOS ANGELES CO.
Urbanized Area
City Area
ENTURA CO.
SAN BERNARDI
RIVERSIDE CO.
ORANGE CO.
PACIFIC OCEAN
SAN DIEGO
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
SCALE
KILOMETERS
MILES

FIGURE 5-27. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN LOS ANGELES, CA, 1980-1983.

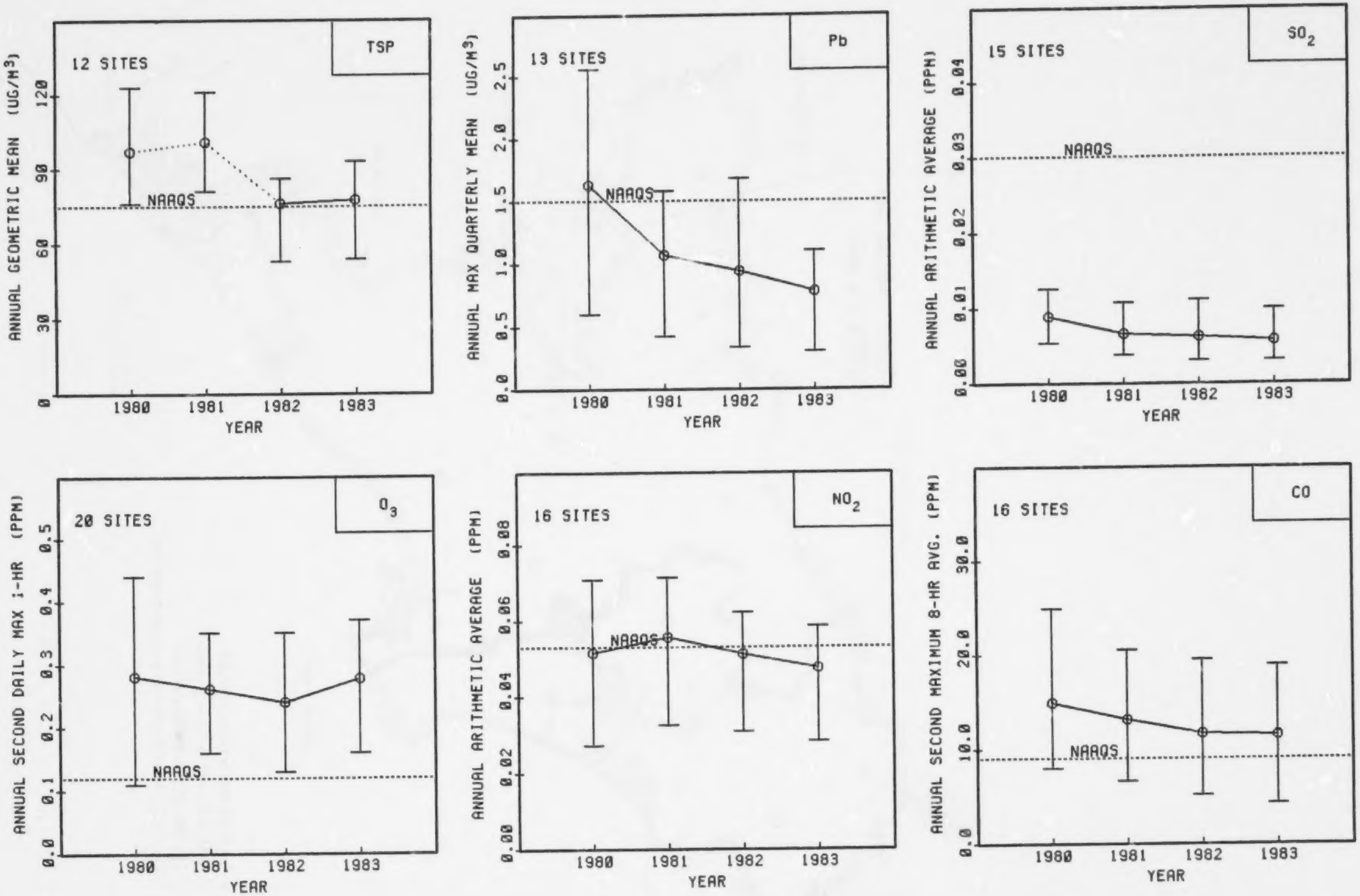


FIGURE 5-28. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE LOS ANGELES-LONG BEACH, CA URBANIZED AREA, 1980-1983.

5.10 PORTLAND, OREGON-WASHINGTON URBANIZED AREA

The Portland urbanized area covers approximately 300 square miles and includes over 1,020,000 people. Approximately 50 percent of the urbanized area population live in Multnomah County, the remaining 50 percent live in parts of Clackamas and Washington Counties in Oregon and part of Clark County, Washington.

The urbanized area is roughly bounded by Hazel Dell and Orchards in Washington to the north; Forest Grove, Oregon to the west; Troutdale and Gresham to the east; and Beaver Creek to the south.

Until the 1940's, Portland was largely a commercial and transportation center. With the introduction of relatively cheap hydroelectric power in the 1940's, metallurgical and chemical industries augmented the ongoing commerce of the area.

The Portland area is about 65 miles from the Pacific Ocean and is partially shielded from the maritime climate of the Pacific Ocean by the surrounding hills and mountains. The winds are generally southeasterly during the winter and northwesterly during summer. The averge precipitation for the area is 37 inches and typically 88 percent of the rainfall occurs in the months of October through May.

The locations of the TSP, Pb, and SO_2 sites used in the trend analysis are shown in Figure 5-29, and the locations for O_3, NO_2, and CO sites are shown in Figure 5-30. The trend graphs for all pollutants are shown in Figure 5-31.

5.10.1 TSP Trends

Figure 5-29 is a map showing the approximate location of the 17 TSP sampling locations operated in the Portland urbanized area during the period between 1980 and 1983 and met the trends criteria. During the period 1980 to 1983, 20 TSP sampling sites operated in the Portland area, and 17 of these sites met the trend criteria and were used in the trend graphs for Portland (Figure 5-31). The composite average has declined over the 4-year period by approximately 47 percent which is more than twice the national decline of 22 percent for TSP. This has occurred because TSP values in Portland during 1980 were greatly elevated due to the fallout from the Mt. St. Helens volcanic eruption. If the 1980 TSP composite average is ignored, the decline in TSP concentrations for the 1981 through 1983 is approximately 21 percent or essentially the same as the national decline. Also, some of the decrease between 1981 and 1982 may have been caused by a change in the filters (Section 3.1.1).

5.10.2 Pb Trends

The Pb data for the Portland area trend analysis includes the SAROAD data base and Pb data from the 1982 and 1983 Air Quality Annual Report produced by the State of Oregon.[15,16] Figure 5-31 shows the composite average of maximum quarterly concentrations of Pb from the 11 of 14 sites which met the 4-year trend criteria. The location of these 11 sites is shown on Figure 5-29. The composite average for Pb in Portland has declined by 55 percent during the period compared to the national rate of 34 percent This difference may be attributed to a State regulation which prohibits the customer from pumping his own gasoline resulting in a lower rate of fuel switching.

5.10.3 SO_2 Trends

The SO_2 trend sites for Portland are shown on Figure 5-29. The composite annual average for SO_2 represents the three of four SO_2 monitoring sites in the Portland area with sufficient data to meet the data criteria. During the period 1980 to 1983, the SO_2 levels at these sites declined by 19 percent or about 4 percent more than the national decline of 15 percent. Large point sources of SO_2 emissions are absent in the Portland area and this is reflected in Portland annual average concentrations of SO_2 which are less than one third of the SO_2 NAAQS.

5.10.4 O_3 Trends

The composite average for O_3 for the Portland area is based on all three of the sites operated during the period between 1980 and 1983. The composite average for the area increased in 1981 over 1980 then declined in 1982 and 1983 for a net increase of 11 percent between 1980 and 1983. This is a different pattern from the national trend for ozone which has shown a decline in average concentrations from 1980 through 1982 with a pronounced increase in 1983. The reasons for Portland's departure from the national pattern appear to be related to the local meteorology. Generally, the high maximum O_3 value trends correspond to the trend in the number of air stagnation days during the spring and summer months. This decrease may also be due in part to a lower rate of fuel switching due to the State law prohibiting customers from pumping their own gas.

5.10.5 NO_2 Trends

The Portland urbanized area was not large enough at the time of the 1970 census to require NAMS NO_2 monitoring. However, there have been studies at two NO_2 sites which were operated for a short period of time during 1980 and 1981. Although neither of the sites met the trend criteria and no trend lines for NO_2 could be prepared, it appears that the NO_2 averages which are about 30 to 50 percent of the NAAQS have remained stable since 1980.

5.10.6 CO Trends

The CO trend for Portland shown on Figure 5-31 is for the five of six sites which met the trends criteria for the 1980 through 1983 period. These sites are shown on Figure 5-30. The composite average declined by 17 percent between 1980 and 1982, then showed a 12 percent increase for 1983 over 1982. This is different than the national trend which showed a decline for each of the years in the 4-year period. The increase in CO concentrations may in large part be attributable to the temporary displacement of significant traffic volumes off Interstate 84 onto other surface and arterial street systems, elevating levels measured at affected sites.

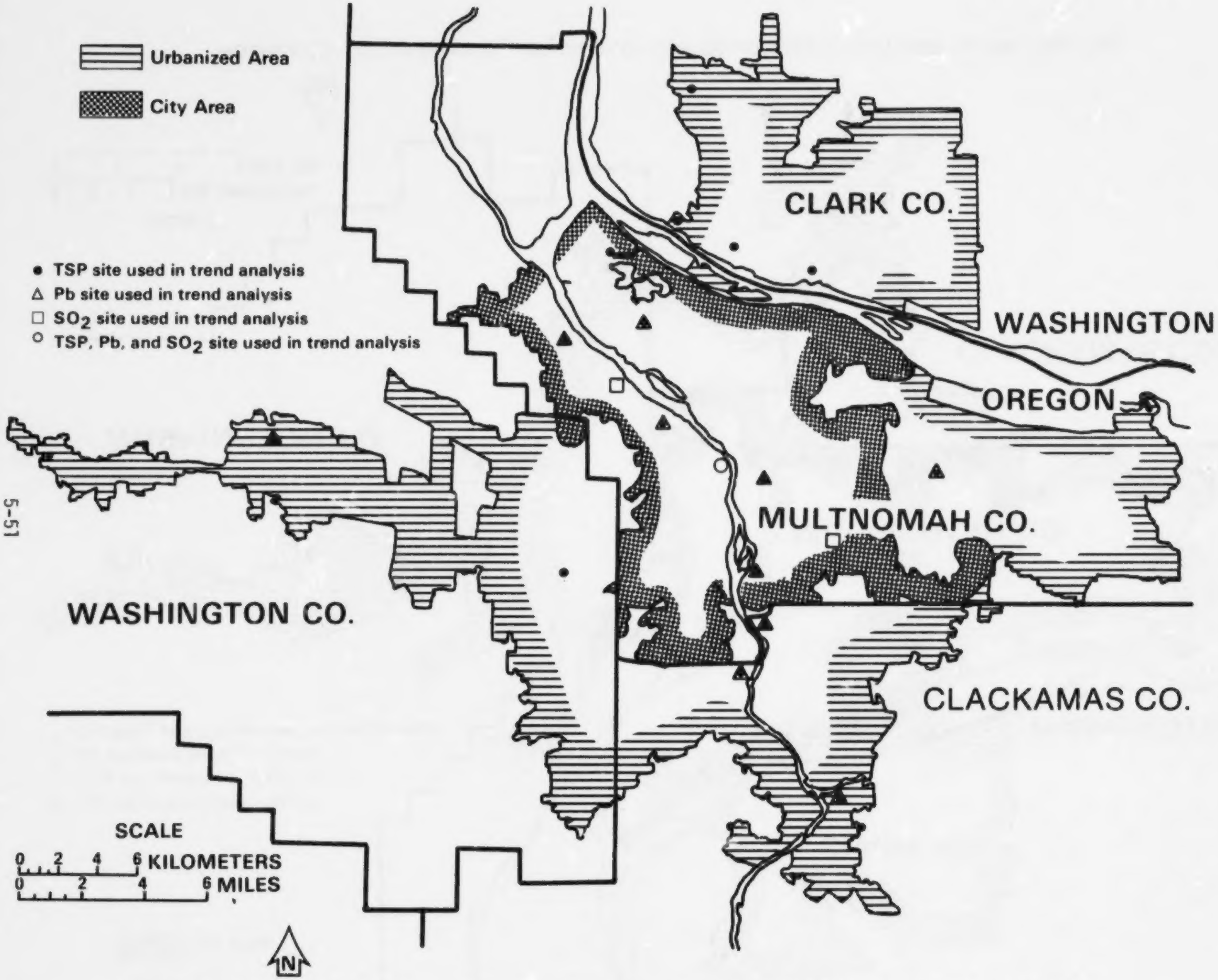

Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N

FIGURE 5-29. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN PORTLAND, OR-WA, 1980-1983.

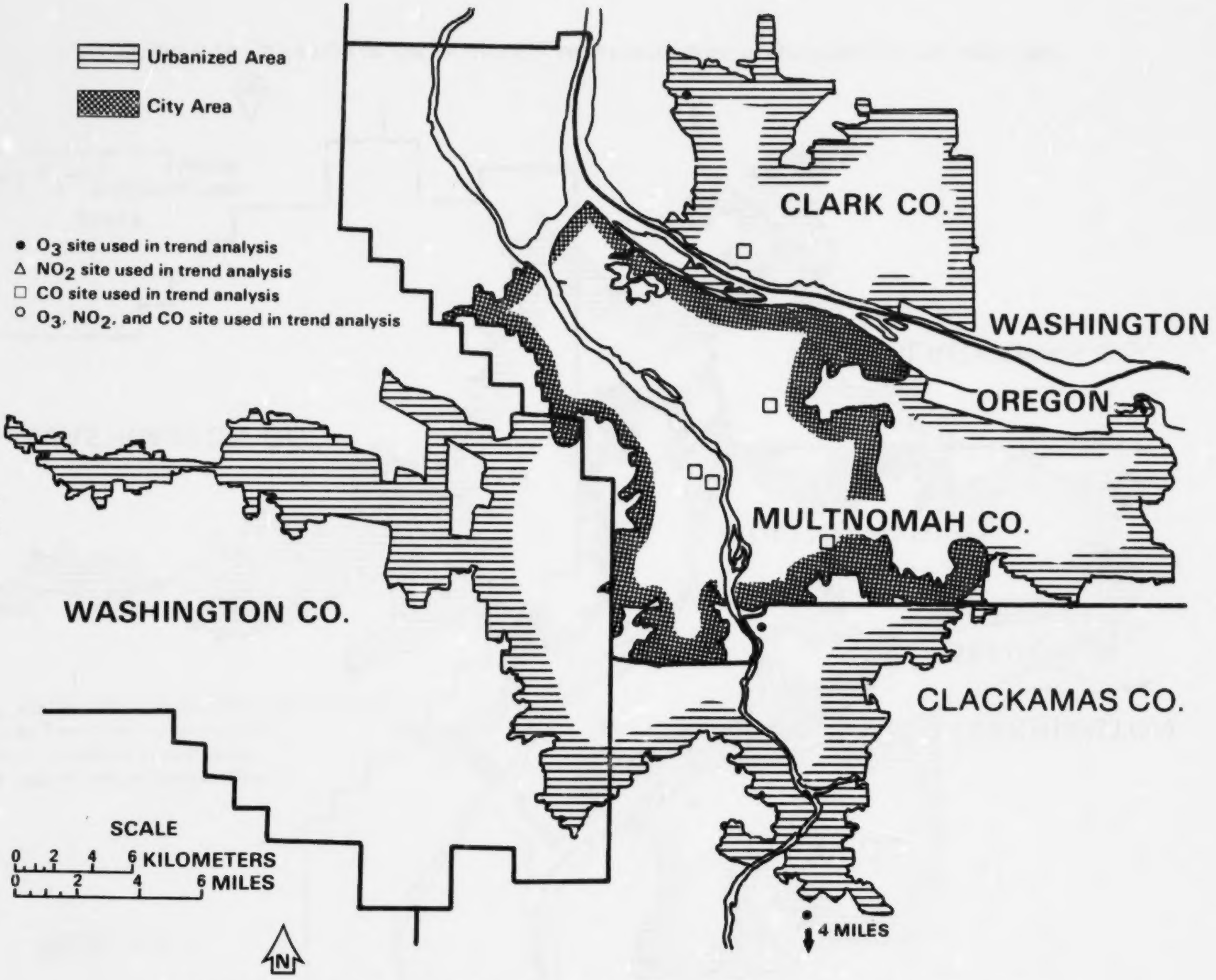

▤ Urbanized Area
▦ City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N
4 MILES

FIGURE 5-30. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN PORTLAND, OR-WA, 1980-1983.

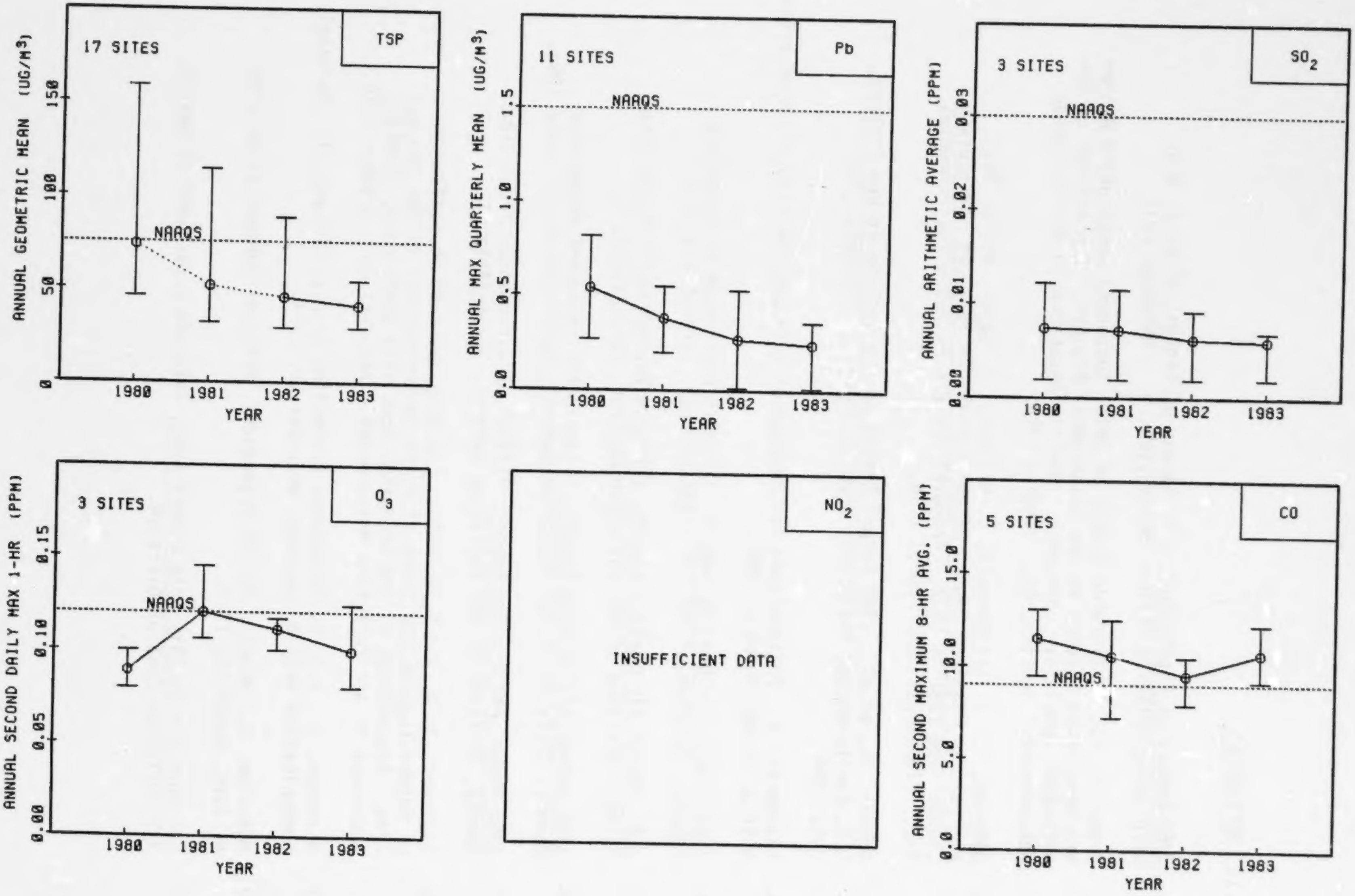


FIGURE 5-31. AIR QUALITY TRENDS IN THE COMPOSITE MEAN AND RANGE OF POLLUTANT-SPECIFIC STATISTICS FOR THE PORTLAND, OR-WA URBANIZED AREA, 1980 - 1983.

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